# The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

VOL. CLII.—No. 3961] LONDON: FRIDAY EVENING, DECEMBER 11, 1931 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.


PUBLIC NOTICES.

**The Government of the** United Provinces invite APPLICATIONS for an APPOINTMENT as PRINCIPAL, Thomason Civil Engineering College, Roorkee, India. Candidates must possess a good Honours Degree in Engineering, or an equivalent qualification, sound administration ability and practical experience of construction and maintenance of engineering works. Preference will be given to candidates who have had successful experience as civil engineers. Experience of teaching at a recognised Engineering College and some knowledge and experience of mechanical and electrical engineering will be regarded as additional qualifications.

Age should be between 35 and 45 years.

Prospect of permanent pensionable appointment after satisfactory completion of period of probation. Pay scale Rs. 1500 a month, rising by annual increments of Rs. 50 to Rs. 2000 a month. (The Government of the United Provinces reserve the right to fix the initial pay at any stage on the time scale.) Free house. Free first-class passage to India. Strict medical examination.

Further particulars and forms of application may be obtained upon request by postcard to the HIGH COMMISSIONER FOR INDIA, General Department, India House, Aldwych, London, W.C. 2. Last date for receipt of applications 9th January, 1932. 7894

**Glamorgan Education Committee.**

MINING & TECHNICAL INSTITUTE & JUNIOR TECHNICAL DAY SCHOOL (BOYS) BRIDGEND.

WANTED, an ASSISTANT, possessing a Degree in Engineering of a British University, for service in the Day School and in the Evening Classes.

Salary in accordance with the Burnham (Technical) Award.

Forms of application and conditions of appointment can be obtained from the undersigned on receipt of a stamped addressed envelope, and should be returned so as to reach him not later than the 22nd December, 1931.

F. E. REES,
Director of Education.

County Hall, Cardiff,
8th December, 1931. 7896

**Borough of Guildford.**

PUMPING STATION SEWAGE DISPOSAL WORKS—CONTRACT No. 1.

The Corporation are prepared to receive TENDERS from experienced Manufacturers for the SUPPLY and ERECTION of (a) CENTRIFUGAL PUMPS, (b) ELECTRIC MOTORS, (c) STEAM ENGINES, and (d) PIPEWORK, at the proposed pumping station at Bellfields Sewage Disposal Works.

The steam-driven pumps are required to lift a maximum flow of 350,000 gallons per hour against a head of 50ft. The duty of the electrically operated stand-by pumps is similar.

General stipulations and conditions of contract and plans may be inspected, and copies of specification obtained, from the Borough Surveyor, J. W. Hipwood, Assoc. M. Inst. C.E., Municipal Offices, Guildford, on payment of Two Guineas, which will be refunded on receipt of bona fide Tender.

As regards erection, the Contractor whose Tender is accepted will be required to comply with the conditions of the Unemployment Grants Committee.

Sealed Tenders, endorsed "Pumping Station, Contract No. 1," must be delivered to the undersigned not later than 10 a.m. on Wednesday, 23rd December, 1931.

The Corporation do not bind themselves to accept the lowest or any Tender, and reserve the right to subdivide the contract, as indicated above.

C. H. WOOD,
Town Clerk.

Municipal Offices, Guildford.
7.12.31. 7883

**London County Council.**

THAMES FLOOD PREVENTION WORKS.

TENDERS are INVITED for the REBUILDING and STRENGTHENING of the GRANITE PARAPET of the RIVER WALL in front of Grosvenor-road and Pimlico-gardens, the REBUILDING at a higher level of the GRANITE COPING and RAILINGS in front of Grosvenor-road and the consequent ALTERATIONS to the FOOTWAY PAVING in Grosvenor-road and Pimlico-gardens.

The specification, form of Tender, &c., may be obtained on and after 14th December on application to the Chief Engineer, Old County Hall, Spring-gardens, S.W. 1, upon payment of £2 by cheque, draft or money order to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 2, No. 3, Warwick House-street, Cockspur street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the CLERK of the COUNCIL at County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 4th January, 1932, will be considered.

The Council does not bind itself to accept the lowest or any Tender. 7895

**The Manchester Steam Users' Association.**

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam, 20, QUAY-STREET, DEANSGATE, MANCHESTER. Founded 1854 by SIR WILLIAM FAIRBAIRN.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers Inspected during construction. 6762

NOTICE TO FOREMEN.

**The National Foremen's Association** is an Association of Foremen formed to represent them on all questions affecting their supervisory interests.

For full particulars apply, GENERAL SECRETARY, 95, Belgrave-road, Westminster, S.W. 1. 7608

## The Engineer

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PUBLIC NOTICES.

**Municipality of the City of** KARACHI (INDIA).

The Municipality of the City of Karachi invite from Manufacturers of Modern Refuse Destructors, SCHEMES, with up-to-date PLANT and MACHINERY for the purpose of DEALING with the TOWN REFUSE, amounting to an average of 200 tons per day.

The scheme should provide for such items of Plant and Machinery as would necessarily be exported to India, giving details of other items of work which can be done locally. Plans and specifications for the necessary buildings must be attached to the quotations.

The scheme should include the services of an expert to erect the plant and run it satisfactorily for a period of nine months before it is handed over to the Municipality.

All further particulars regarding the site of the destructor, prices of materials available locally, &c., can be had on application to the undersigned.

The schemes, with quotations, should reach the undersigned within three months from the date of this notice.

Details of the analysis of the average daily town refuse are given below :—

| | Per cent. |
|---|---|
| (1) Vegetable matter, grass, leaves, &c..... | 39 |
| (2) Dung and sweepings, containing 56‡ per cent. of sand and grit, 12 per cent. volatile ..... | 59 |
| (3) Paper, rags, tins, and metal, glass, earthenware, &c. (tins, metal, glass, earthenware, &c., forming 1‡ per cent.) | 2 |

K. N. RAMASUBBA AIYAR,
Chief officer.

18th November, 1931. 7880

G.R.

**The Commissioners of H.M.** Works and Public Buildings, &c., offer FOR SALE by TENDER a QUANTITY of MACHINERY lying at the Ministry of Labour Training Centre, Ascot Works, Letchworth, including :—

1 Norton CRANK BALANCING MACHINE, ‡ H.P. C.C. electric motor, by B.T.H., 250 volts, 1000 r.p.m., starter, switch and wiring.

1 No. 66 "Defiance" MOTOR FLY-WHEEL BALANCING MACHINE with countershaft and striking gear.

1 20in. DRUM SANDER, by Sagar, table 3ft. 6in. by 2ft. 6in., fast and loose pulleys and striking gear.

For forms of Tender apply to the CONTROLLER OF SUPPLIES, H.M. Office of Works, King Charles-street, S.W. 1. 7887

PUBLIC NOTICES.

**North Kesteven Rural District** COUNCIL.

EASTERN AREA WATER SCHEME.
CONTRACT No. 3 (IRON PIPES).

WATER SUPPLY FOR THE PARISHES OF METHERINGHAM, DUNSTON, NOCTON, BRANSTON, HEIGHINGTON, WASHINGBOROUGH, WADDINGTON, HARMSTON, COLEBY, BOOTHBY GRAFFOE, AND NAVENBY, LINCOLNSHIRE.

The above-named Council invite TENDERS from responsible Ironfounders for the SUPPLY and FREE DELIVERY at site of works of CAST IRON PIPES, SPECIAL CASTINGS, &c., in connection with the above waterscheme.

The various lengths and sizes of piping are as follows :—13,850 yards of 7in., 13,014 yards of 6in., 3668 yards of 4in., 39,048 yards of 3in., and 17,672 yards of 2in. diameter, including a quantity of special castings.

Full particulars, with specification, bill of quantities and form of Tender, may be obtained at the offices of the Engineers, Messrs. Elliott and Brown, Chartered Civil Engineers, Burton Buildings, Parliament-street, Nottingham, after the 12th day of December, on deposit of Three Guineas, by cheque, which will be returned on receipt of a bona fide Tender not afterwards withdrawn, and the return of all documents lent the Contractor for the purpose of making up his Tender, within seven days of the notice informing him a Tender has been accepted.

Sealed Tenders, endorsed "Tender for Iron Pipes, Contract No. 3," must be delivered to the undersigned not later than the first post on Tuesday, the 22nd day of December, 1931.

The lowest or any Tender will not necessarily be accepted.

By Order,
ROBERT EPTON,
Clerk to the Council.

2, Bank street, Lincoln,
4th December, 1931. 7879

SITUATIONS OPEN.

WANTED, EXPORT ENGINEER SALESMAN with good technical training and sound selling experience for heavy machinery. Essential correctly write and speak English, German and French. Age limit 43. Part time travelling Europe.

Address, sending photograph and references, stating nationality, full particulars of education, engineering training, and commercial experience, 7871, The Engineer Office. 7871 A

PUBLIC NOTICES.

**Stockport Corporation Water-Works.**

GOYT VALLEY SUPPLY—CONTRACT No. 3.
CAST IRON PIPES AND SPECIALS.

The Waterworks Committee invite TENDERS for the SUPPLY of about 6250 TONS of CAST IRON PIPES and SPECIALS, from 4in. to 30in. diameter, together with a FEW LENGTHS of STEEL-FLANGED PIPES, 12in. and 15in. diameter.

The drawings may be seen and specification and schedule, with form of Tender, obtained on application to Messrs. G. H. Hill and Sons (Manchester), Civil Engineers, 40, Kennedy-street, Manchester, upon receipt of a cheque for Three Guineas, which will be returned to the applicant provided that he shall have sent in a bona fide Tender and shall have not withdrawn the same, and shall have returned the documents and drawings lent to him.

A limited number of sets of the drawings are available, and will be lent to persons tendering in priority of application, upon receipt of the sum of Two Guineas, which sum will not be returned.

Sealed Tenders, endorsed "Goyt Valley Supply, Contract No. 3," and addressed to the "Chairman of the Waterworks Committee," must be delivered at the Waterworks Offices, Town Hall, Stockport, not later than the 31st day of December, 1931.

The Committee do not bind themselves to accept the lowest or any Tender.

FRANK KNOWLES,
Town Clerk.

Town Hall, Stockport,
December 8th, 1931. 7889

**County Council of Middlesex.**

APPLICATIONS are INVITED as follows :—

NOTE.—All persons appointed in a permanent capacity will be required to undergo such medical examination as the Council may direct, and subject to passing the same, to contribute towards the County Council's Superannuation Fund unless subject to the Poor Law Officers' Superannuation Act, 1896.

SALARY ABATEMENTS.—All appointments over the value of £150 per annum (including value of emoluments) are subject to the following temporary abatements, namely :—

For the first £150 per annum, no abatement.
For the next £100 per annum, 2½ per cent. abatement.
For the next £500 per annum, 5 per cent. abatement.

Superannuation contributions and the calculation of superannuation allowances to be on the remuneration as unabated.

AT THE CENTRAL MIDDLESEX COUNTY HOSPITAL, ACTON-LANE, WILLESDEN.

CHIEF ENGINEER.—Wages £6 per week (non-resident). Candidates must have a thorough knowledge of electrical and general engineering works; be fully conversant with the construction of and working of steam and electrical generating plant, heating, hot and cold water supplies, water softening, laundry and kitchen plant, bells, telephone and wireless equipment, refrigerating plant, sanitary and fire appliances, lifts and workshop tools. They must be capable of controlling the subordinate staff, be able to keep the necessary log sheets and maintain the plant to the satisfaction of the County Council's Superintending Engineer. The Council will require to be furnished with evidence that candidates have served an apprenticeship with a reputable engineering firm. Applications, stating age and experience, with copies of three recent testimonials, to be sent to the undersigned, endorsed "Chief Engineer, Central Middlesex County Hospital," so as to be received not later than the 2nd January, 1932. (C/44.)

By Order,
ERNEST S. W. HART,
Clerk of the County Council.

Guildhall, Westminster, S.W. 1. 7888

SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

W. H. ALLEN, SONS and CO., Ltd., Bedford, wish to THANK APPLICANTS to their Advertisement for Electrical Designer and to advise them that the POSITION is now FILLED. 7886 A

WANTED, a DRAUGHTSMAN with Experience of Hydraulic Press Work and Pumps; a thorough knowledge of up-to-date design is essential. Applications must state experience, age, and salary required. —Address, 7898, The Engineer Office. 7898 A

WANTED AT ONCE for N. London, YOUNG MEN (not over 25), with experience in Rate Fixing Dept. of Mass Production Works. Good prospects for suitable men.—Address, P1771, The Engineer Office. P1771 A

WANTED by Firm in Midlands, DRAUGHTSMAN, experienced in Automobile Work. State age and salary expected.—Address, 7901, The Engineer Office. 7901 A


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## SITUATIONS OPEN.

A FIRM of ENGINEERS REQUIRE for the West Indies, an ENGINEER with experience in Construction, Maintenance, and Management of Waterworks and of Distribution and Waste Detection. The engagement will be for three years, with prospect of a permanent appointment. Salary £600, rising to £800.

Applicants must be of British nationality, and should be between the ages of 30 and 40. Preference will be given to a Member or Associate of the Institution of Civil Engineers.

Medical examination will be required before final acceptance.

Application, stating age, birthplace, and whether married or single, also giving details of education, training, and experience, with special reference to qualifications mentioned above, and accompanied by copies of not more than four testimonials of recent date, based on personal knowledge, to be lodged with "WATERWORKS," c.o. William Porteous and Co., Advertising Agents, Glasgow, not later than 26th December, 1931. 7885 A

NIGERIA.—ENGINEER for Cold Storage and Ice-making Plants; experience with Ammonia Compression Plant, Gas Engines, Producers and Electric Motors, is essential. Some commercial experience a recommendation. Full particulars of experience and age.
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COMPETENT MECHANICAL DRAUGHTSMAN, used to Heavy Machinery, REQUIRED by Engineering Firm in South-East Midlands.—Address, stating age, experience, and salary required, 7893, The Engineer Office. 7893 A

## SITUATIONS WANTED.

ABROAD.—MECHANICAL ENGINEER (31), with previous experience abroad in charge construction, operation and maintenance locomotives, heavy haulage plant, B. and W. boilers, water pumping plant, Diesel and I.C. engines, conveying, crushing and drying machinery, repair workshops, DESIRES responsible POST abroad; steam certificate, Malay.—Address, P1818, The Engineer Office. P1818 B

CEMENT WORKS ENGINEER and GENERAL MANAGER, recently returned from abroad, having built new works, DESIRES SIMILAR APPOINTMENT, home or abroad. Life-long experience of cement industry.—Address, P1824, The Engineer Office. P1824 B

ELECTRICAL ENGINEER (29), Completed Four years' agreement with large company in East, SEEKS PROGRESSIVE APPOINTMENT. Extensive experience of erection 3-phase transmission lines, sub-station equipment, distribution overhead and cable of large network; motor installations, complete equipment workshops and petroleum refining plants.—BM/CPFH, London, W.C. 1. P1812 B

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EXPERIENCED ENGINEER is DESIROUS of OBTAINING TRANSLATION of TECHNICAL and METALLURGICAL MATTER from the French Language, Reviews of Technical Publications, Descriptions of Plant, &c.—Address, P1802, The Engineer Office. P1802 B

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MECHANICAL ENGINEER (31), 9 Years British rly. abroad, sound D.O. and test experience, economical works management and maintenance of steam and hydraulic plant, specialised in use of oil fuel, lately disengaged from works manager's position N. of England, fluent Spanish, DESIRES POSITION OF TRUST.—Address, P1798, The Engineer Office. P1798 B

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STEEL AND MOTOR EXPORTS—AGENTS WANTED with good connection among exporters of steel goods, motor cars, &c., for sales on commission of Rust Proof Mixture and of Adhesive.—Address, P1743, The Engineer Office. P1743 D


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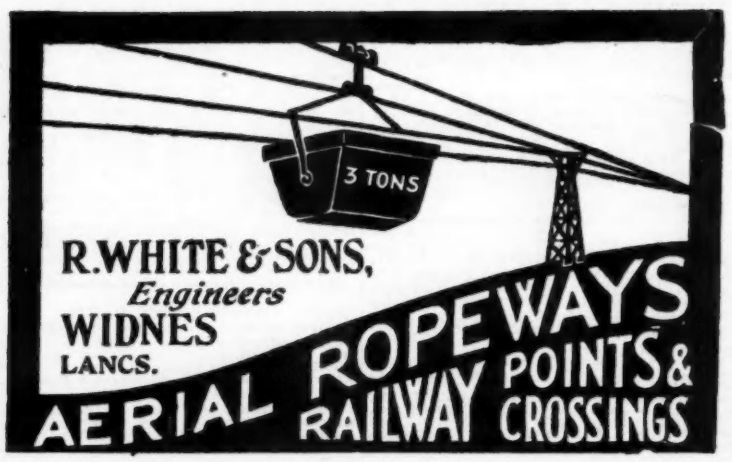



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P1804 I


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# A Seven-Day Journal

## Humber Coal.

IN a report presented by the Humber Coal Exporters' Association to the Hull Chamber of Commerce and Shipping recently some reasons were given for a decline of approximately one and a-half million tons in the amount of coal exported from the Humber for the year ending September 30th, as compared with the figures for the preceding year. Foreign shipments were 4,552,914 tons and 3,072,730 tons for the present year and last year respectively, reckoning to the end of September. It is stated that prior to the war much of the coal from the Midlands area was shipped to countries bordering on the North Sea and the Baltic, and that Russia, Germany, Denmark and Norway took about 80 per cent. of the total, the rest of Europe accounting for about 18 per cent. The closing of the Russian outlet, together with competition from Poland and other European coal producers, led to a decline in exports to Scandinavia and the Baltic. Other factors contributing to the decline were the high cost of production and excessive railway and port charges, while import restrictions in other countries and uncertainty following upon the introduction of the Coal Mines Act had also had an effect. In reference to that Act, the report states that the marketing scheme as at present constituted must hinder any revival of the export trade. In the report there is a comparison of the figures for the industry as a whole for the first half-years 1930 and 1931. In the latter year production was 12¼ million tons less than in the former; foreign exports were less by about eight million tons, and seventy thousand fewer miners were at work.

## Miss England the Third.

SPEAKING at a dinner of the Authors' Club last Monday, Lord Wakefield announced that there would be a "Miss England the Third." He spoke also of the problems connected with the quest for high speed upon the water. He reminded his hearers that to attain the water speed record of 110 m.p.h. held by "Miss England II.," two aero-engines similar to those used for the Schneider Cup machines and capable of developing between them 4000 H.P., had to be used. Water obviously offered the greatest resistance to motion of the three elements air, land and water, and since speed was entirely a question of overcoming resistance it was easy to understand that engines which could easily attain 350 m.p.h. or more in the air could only reach a mere hundred or so when placed in the hull of a speed boat. Later, Lord Wakefield explained that his interest in this quest for speed records turned not so much on speed itself as on more general grounds. The quest was of value to the industries most closely concerned, and at the same time, was of national interest. By striking achievements in mechanically attained speed we could make known our supremacy in that department of industry. It was with that in mind that he had set himself, first with the aid of the late Sir Henry Segrave and later with that of Mr. Kaye Don, to complete the trinity of speed records held by this country, by securing the world's water speed record. Referring to "Miss England III.," he stated that Mr. Kaye Don and other experts thought that certain modifications would give the pilot greater control and greater safety at high speeds, and it was his opinion that the vessel in its new form would maintain the record against any possible challengers. "Miss England II." would not be scrapped, but would be kept in reserve.

## Safety in Mines.

A CONFERENCE was held last Saturday at Manchester on safety in mines, and was attended by about 1000 people interested as owners, officials, or workers in mines in Lancashire and North Wales. Mr. Foot, Secretary for Mines, who presided, drew attention to the fact that, though the importance of stimulating interest in safety work had been emphasised by recent disasters, those who were more immediately concerned with the mines knew of the constantly recurring loss of life—one here, two there—taking place every day, the tragedy of which, though not as large, was just as real. During 1930, 1000 workers, in round figures, lost their lives in the mines, and there were 150,000 non-fatal accidents amongst a total number of 950,000 men employed in the industry. Sir Henry Walker, Chief Inspector of Mines, gave some statistics with regard to deaths and accidents in mines in the Lancashire and North Wales coalfields. In the years 1927 to 1930 inclusive, 81, 76, 83, and 78 per cent. respectively of all fatal and serious accidents underground had been due to causes other than explosions—mainly falls. Although there had been some improvement in regard to accidents from that cause, yet a comparison of the recent combined injury and death rates with those for 1901 to 1910 gave very little ground for satisfaction, while as regards accidents in connection with haulage, there had been no progress towards safety at all. Accidents in falls and haulage had always been responsible for the great majority of casualties. Even in the decade 1901 to 1910, which included the great explosions at the Maypole and the Hulton collieries, the number killed by falls and haulage was eight times the number killed by explosions. Sir Henry Walker paid tribute to the pioneer work by which the number of fatalities caused by explosions had been so much reduced, and went on to show how great was the importance of proper ventilation in this connection. Reverting to falls, he urged that greater attention should be given to the proper support of working places and roofs, and expressed a strong preference for the use of steel props or girders in the deep mines of Lancashire where great pressures were experienced.

## The Smithfield Club Show.

ON December 12th, 1856, THE ENGINEER, then in the first autumn of its existence, devoted several columns to the Smithfield Club Show, held in the Bazaar, in King-street, Baker-street. The description of the exhibits was what an artist would call "conscientious." We missed nothing, mixing up roots and our "native ceralia" with implements and corksoles for horses. A few years later we paid great attention to implements, and in all the succeeding shows we found much that attracted our attention by its importance and novelty. For the first time the long sequence is broken this year, for the Smithfield Club Show has fallen from its high position as an exhibition of engineering products, and a visit to the Agricultural Hall this week showed that whilst farm implements of a familiar kind were plentiful, the "heavier" engineering exhibits were but few in number. We trust that this departure from long tradition is only temporary and no more than a reflection of the industrial depression. It must be remembered that before the War, with its unhappy sequel, the agents of the great agricultural engineering firms from all parts of the globe used to assemble at the Show to see the latest products of their principals and to place orders for the coming months. Great dinners used to be given on those occasions by several firms and the number of agents that were present, and their geographical distribution, impressed the guest with the magnitude of the industry. The trade has for the time being fallen away and several of the firms that once entertained so royally entertain no more. There is little occasion for the display of products—since large orders are not being placed—and we assume that to that fact we must ascribe the lack of novelty in the technical exhibits. We are glad to say that many, if not all, the old firms still retain touch with the Show, and we are confident that when trade comes back once more we shall again find reason to give illustrated descriptions of the exhibits.

## Safety Glass.

UP till the present time it has been impossible to make safety glass entirely British. As is well known, such glass consists of a sandwich composed of two sheets of glass enclosing a sheet of celluloid, and the raw materials for the manufacture of the latter have had to be obtained from abroad, Germany being the chief source of supply. After nearly two years of research, it is now reported by a committee, of which Dr. Hepworth, of Imperial Chemical Industries, is chairman, that celluloid suitable for use in safety glass can at length be made here. The committee to which reference has been made was formed under the title of the Safety Glass Committee to investigate how far it was practicable to manufacture the material in this country, and had the co-operation of the Triplex Company, the British Xylonite Company, and Imperial Chemical Industries. As a result of its researches, it is probable that safety glass will be produced here at a cost no higher than that of the imported material. The committee carried out its experiments in various parts of the country. One of the chief components of celluloid, nitro-cotton, has already been produced of the required standard of quality at the Nobel factories at Ardeer and Stevenston, in Ayrshire, while the celluloid itself has been made at Manningtree in Essex by the British Xylonite Company. This is excellent news, coming, as it does, on top of the new regulation concerning the compulsory use of safety glass in motor vehicles.

## Proposed Conference on Fire Testing.

As a result of the work of the representative British Engineering Standards Association Committee, appointed about two years ago to draw up standard definitions for the terms "fire resisting," "incombustible," &c., as related to building practice, and to define standard methods of tests, the situation as regards fire testing is now much clearer. The findings of the Committee are embodied in the Draft Tentative British Standard Definitions and Methods of Test for Fire Resistance, Incombustibility, and Inflammability of Building Materials and Structures," and it appears that the tests enumerated provide a means of evaluating building materials and structures in respect of the fire risks involved by their employment in practice. Perhaps the most important of the test methods which have been defined is that for the fire-resistance of "elements of structure," *e.g.*, roofs, floors, &c. The British standards require that these "elements of structure" shall be tested under properly controlled and reproducible conditions, on a full scale and while performing the functions which they would be called upon to fulfil in actual practice. This full-scale testing entails, of course, the provision of special furnaces and loading devices and a trained staff. Many requests for such tests on building materials and methods of construction have been put to the Building Research Station during recent years. But it has not been possible to meet these requests, first, because a sound basis for fire testing had not been enunciated; secondly, because the necessary technique had not been developed at the Station; and, thirdly, because the necessary testing facilities are not available either at the Building Research Station or elsewhere. In these circumstances the Department has decided to invite those firms which are interested in the provision of these facilities in a central and authoritative testing laboratory, and which are prepared to bear a share of the financial support necessary for the establishment of such facilities to attend a conference to discuss how best to attain the desired end. The date of the conference has not yet been settled.

## An Electrical Fusion Scheme.

WITH a view to securing parliamentary sanction for the amalgamation of eight electrical undertakings in Northumberland, Durham, Cleveland, and North Yorkshire, a Bill has been lodged with the Ministry of Transport. If the amalgamation is approved, it will be known as the North-Eastern Electric Supply Companies, and will have its head offices at Carliol House, Newcastle, which is the present headquarters of the Newcastle-upon-Tyne Electric Supply Company. The concerns involved represent a capital of £14,000,000, and the area of supply is 4700 square miles. The total connections exceed 790,000 horsepower. The companies concerned include the Durham Distribution Company, the Houghton-le-Spring Company, the Tees Company, the Cleveland Power Company, and the Northern Counties Company. Although it is expected that economies will result from the scheme, the amalgamation will have no retarding effect on the extensive projected schemes which the various undertakings have in hand, and the general consumer will not be affected.

## The Late Mr. J. T. Marshall.

A LONG life spent in the endeavour to improve the efficiency of the steam engine, and particularly of the locomotive, was brought to a conclusion by the death, on December 6th, at the age of seventy-six years, of Mr. James T. Marshall. Mr. Marshall was a member of the family of the same name with which the town of Gainsborough is so familiarly identified. While serving his time he was, among other things, engaged in the manufacture of a pair of engines which were required for picking up a fractured telegraph cable in the Atlantic. In the early part of this century, while he was working at the Boyne Engine Works at Leeds, he designed a special type of valve gear for locomotives, which was, first of all, fitted to a tank engine for hauling heavy coal trains, and afterwards to an express locomotive on the Great Southern and Western Railway of Ireland. We described this gear in our issue of November 3rd, 1905. Its special object was to effect a quicker opening and closing of the steam admission valve than in gears previously in use, and the results achieved were good. For a number of years since that period he had been engaged in the design of a further form of valve gear—also particularly applicable to locomotives—from which he expected even greater things. The gear was applied some year or two back to an engine built at Gainsborough, with, we believe, satisfactory results, but, so far as we are aware, it has not been widely developed.

## The Shannon Power Scheme.

THE report of the auditors on the accounts of the Irish Electricity Supply Board for the year ended March 31st, 1930, shows that the Board's records have been allowed to get into a very unsatisfactory condition, and a large staff has been hard at work on the task of trying to put the accounts in order. Up to the present, the work has involved the Board in an expenditure of £7500, and the task is still far from complete. The auditors strongly criticise the unsatisfactory condition of the books and records, and state that they have been unable to obtain verification of part of the capital expenditure on the distribution system. No provision has been made for depreciation or for bad or doubtful debts. The auditors are also unconvinced as to the accuracy of the amount included in respect of stocks on hand. The records of the stores department, which controlled a substantial portion of the Board's expenditure, were found to be very defective. During the audit bundles of dockets were discovered which had been mislaid and omitted from the accountancy records. The merchandise trading accounts were found to be inaccurate, and there was no record of the details and value of the assets taken over with the undertakings of the local authorities. The pricing of the stocks lists in the stores department, it is added, had been carried out carelessly, and the auditors were unable to ascertain the extent to which the accuracy of the accounts were effected by the lack of proper control over materials. During the year 1929–30 there was a deficit of £35,000 on the trading account.

# The Laws of Ship Resistance.

By G. S. BAKER.

No. IV.*

RESTRICTED WATERS; RIVER STEAMERS AND BARGES.

IF a vessel is passing through a channel of gradually restricted cross-sectional area, the cross section of the stream tubes around the ship must also be gradually reduced, and the changes of velocities and pressures must therefore be increased.

Fage has calculated the effect of a boundary on the two dimensional flow around a series of Rankine ovoid sections. He shows that when the overall dimensions of an oval are relatively small compared with the depth of the channel, at any point on the ovoid, the ratio of the velocity in the channel to that in an infinite stream, is almost constant over the surface, except quite close to nose and tail. But when the oval is relatively large there is a progressive and marked drop in this ratio as the position of the point on the surface moves from amidships towards the nose. It also appears from these calculations that comparing a long and fine form—in which the stream velocity amidships relative to the velocity of advance is small—with a shorter form of equal midship area in which the stream velocity amidships in an infinite fluid will be higher than before, the former feels the boundary more, and has all its velocities increased more, for a given depth of channel. Put into ship language, this means that a long hull of given draught will feel the bottom more than a short one of the same draught and curve of areas, at any given speed.

These changes in velocity and pressure around the hull will affect all three forms of resistance—frictional, eddy and wave making—in different degrees, according to the circumstances. Since the frictional resistance of any surface varies approximately as the square of the velocity of the water passing it, and this is increased in shoal water, there will be an increase of frictional resistance. The percentage will be practically the same at all speeds, since it only depends on the mean increase of velocity, which is independent of speed.

The conditions existing in shoal water are much more favourable to eddy-making than those in deep water. The normal flow of water from the bow underneath the hull becomes restricted, and the main flow therefore tends to become largely two dimensional around the sides, instead of three dimensional, with quicker curvature to the streams and more rapid changes of pressure and higher stream velocities along the sides amidships. This demand for high water velocities is met by a reduction of pressure, which shows as a general fall in the level of the water amidships, the ship sinking with the water level and so still further restricting the flow under the bottom. Again, in passing the after body these high-velocity streams have to close in around the hull along more or less horizontal instead of diagonal lines, since the bottom flow is largely cut off. These lines are materially steeper than the diagonals, and in consequence there is a greater chance of the flow breaking down. This is an effect present at all speeds, and if it could be said that the formation of eddies was independent of speed—which is not quite true for a ship—this effect would entail a percentage increase of resistance, constant at all speeds for any given depth of water. But when the depth of water between the keel and the bottom of the channel is only a few feet, the clearance of the vessel diminishes with speed until the keel drags on the bottom, the flow under the hull is then limited and intermittent, and eddy-making increases rapidly with speed under these conditions.

*Wave-making in Shoal Water.*—Shallow water waves, irrespective of their origin, differ in some respects from deep sea waves. The crests are more peaked, and the hollows more extended. The particles move in ellipses with the long axis horizontal, instead of in circles as with deep water waves. If $d_w$ is the depth of water in feet, L the length of a wave of velocity V in knots, and $a$ and $b$ are the horizontal and vertical axes of the surface ellipse, the ratio $(b/a)$ is given by :

$$\frac{b}{a} = \frac{\varepsilon^{\frac{4\pi d_w}{L}} - 1}{\varepsilon^{\frac{4\pi d_w}{L}} + 1} \quad . \quad . \quad . \quad . \quad (14)$$

which reduces to :

$$\frac{b}{a} = \frac{2\pi d_w}{L}$$

when $d_w$ is small relative to L.

The velocity of a wave in terms of its length is now given by :

$$V^2 = 1{\cdot}8\ L \tanh \frac{6{\cdot}3\ d_w}{L} \quad . \quad . \quad . \quad (15)$$

and the group velocity is somewhat greater than one-half the velocity of the individual waves. The smaller the ratio $\frac{d_w}{L}$, the lower becomes the speed for any given wave length. When this ratio is approximately one-fourth, the speed for a given wave length is 5·0 per cent. less than in deep water, the fall in the group velocity being somewhat less than this. If the depth of water relative to the length of wave is very small, the above equation reduces to :

$$V^2 = 11{\cdot}3\ d_w \quad . \quad . \quad . \quad . \quad . \quad (16)$$

These waves are called waves of translation. Simple straight crested waves cannot be formed at a speed higher than that given by this equation. Havelock has shown that the wave-making resistance of a surface pressure disturbance symmetrical about a point will increase with speed until a maximum is reached, which in very shoal water is at the critical speed given by equation (16), but in deeper water moves to a speed nearer that for the ordinary wave resistance humps in deep water. His curves are given in Fig. 11. The wave-making length of the disturbance is $2\pi l$, and the depth of water $d_w$ is $x l$. The following table, based on this work, shows the variation in the speed of the ordinary resistance humps and the shallow water hump with depth of water :—

TABLE XIII.—*Effect of Shallow Water on Resistance Humps.*

| $\frac{\text{Depth of water}}{l}$ | $\left[\frac{\text{Velocity for shallow water maximum resistance}}{\text{Velocity of wave of translation}}\right]$ | $\left[\frac{\text{Speed for ordinary resistance hump}}{\text{Speed of this hump in deep water}}\right]$ |
|---|---|---|
| 2·0 | 0·89 | 0·97 |
| 1·43 | 0·92 | 0·92 |
| 1·0 | 0·97 | 0·82 |
| 0·75 | 1·0 | Indefinite |

The table and curves show the marked drop in speed of the *ordinary* resistance humps, and the large growth of resistance in very shallow water.

The above curves are for a pressure disturbance of fixed intensity. When the disturbance is caused by a ship, the general character of the shoal water effect will be the same except that in this case the intensity of the pressures around the hull increases as the depth of water diminishes, and the resistance humps will be emphasised.

*Critical Ship Speeds.*—If the ship is of fairly high prismatic coefficient, the usual humps will tend to form, but at materially lower speeds than in deep water. Since cargo vessels if properly designed have no material humps in their resistance curves—within the practical speed range—and cannot approach the speed of translational waves in any but the shallowest waters, they are not concerned in this wave phenomenon. They are subject to the increases in resistance due to friction and eddy-making, but unless their speed is above that given by :

$$V^2 = 3{\cdot}0^*\ d_w \quad . \quad . \quad . \quad . \quad . \quad (17)$$

there will be no sudden abnormal growth of wave resistance.

For faster vessels of liner type the case is somewhat different. In deep water there will be a hump in the C curve at a P value of 0·9, and this in very shoal water will fall to a speed given roughly by P=0·74, and this hump will inevitably grow to large proportions in shoal water. Experiments by Schütte and in the National Tank show that abnormal resistance will commence at a speed given approximately by :

$$V^2 = 5{\cdot}3^*\ d_w \quad . \quad . \quad . \quad . \quad . \quad 18^*$$

If this should fall at a P a little below 0·74, the growth of resistance will be so serious that the ship will not be able to proceed at a speed greater than that given by the formula. Thus, a vessel of prismatic coefficient 0·65—about the average of this type—will meet this condition when $d_w$ is equal to 0·12 L, the limiting speed then being $0{\cdot}8\sqrt{L}$. If the depth of water is sufficient for the vessel to pass the normal wave hump at about P=0·74, before the speed given by equation 18 is reached, there will be marked growth in the waves at both this hump and at the speed given by equation 18, with a maximum value to the resistance at each speed in isolated cases. If such vessels are "pushed" up to the speed given by equation 16—a feat possible only on a model—a marked hollow forms at the after body and a large wave crest just under or just clear of the stern, and the resistance increases to many times the deep-water value.

With high-speed vessels such as cross-Channel steamers and destroyers, there is a wide range of speed whose lower limit is about P=1·1, over which the main transverse wave pattern consists of a marked hollow around the after end, followed by a large transverse wave clear of the stern, with the normal echoes trailing behind it. When the speed of the shallow water wave is reached, this hollow and the succeeding crest increase considerably and there is a very large increase in the wave-making resistance. If the depth of water is small relative to the length of this ship, at speeds above that of the shallow water wave, simple transverse waves cannot be formed, and the resistance hump is then followed by a marked reduction of resistance below that for deep water. If the depth of water is about 0·16 L, or above, a form of transverse wave will continue at higher speeds, and the reduction of resistance will not be so apparent.

There are many model and ship trials which show these results. Those due to Yarrow and Watts are given in Fig. 12. The lower diagram gives model data brought up in scale to correspond to a destroyer of 225ft. length. The upper diagram gives the data obtained on the trials of the destroyer "Cossack"

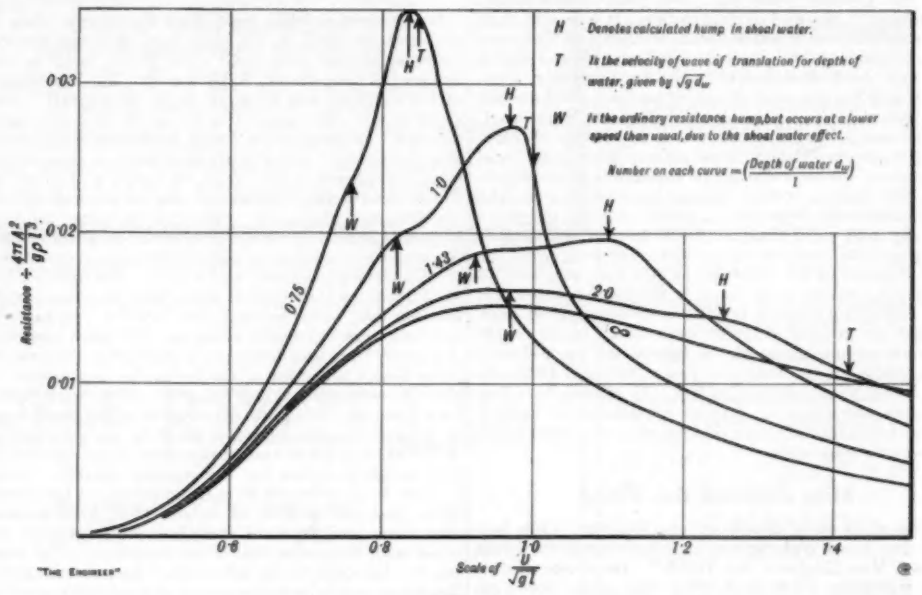



FIG. 11

*Wave Resistance in Shoal Water of Varying Depth, due to a Surface Pressure Disturbance Consisting of Two Symmetrical Humps with Hollow Between, Travelling at Speed v. Distance Between Humps equal to l.—Havelock 1921.*

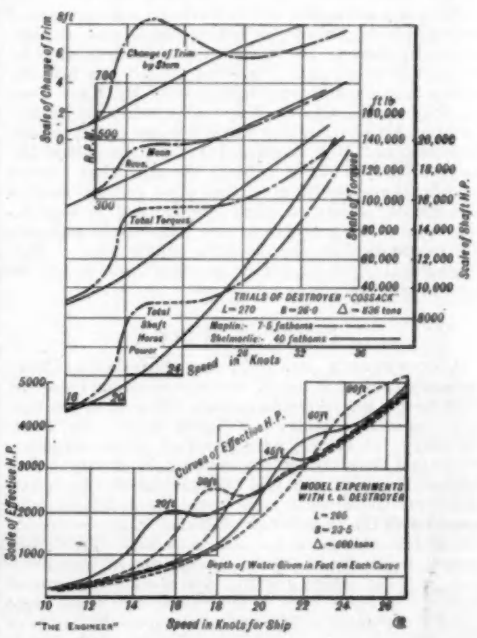

Scale of Change of Trim
Change of Trim by Stern
Mean
Total Torques
R.P.M.
Scale of Torque
Scale of Shaft H.P.
TRIALS OF DESTROYER "COSSACK"
L = 270 B = 26·0 Δ = 836 tons
Total Shaft Horse Power
Speed in Knots
Scale of Effective H.P.
Curves of Effective H.P.
MODEL EXPERIMENTS WITH T. B. DESTROYER
L = 265
B = 23·5
Δ = 669 tons
Depth of Water Given in Feet on Each Curve
"THE ENGINEER"
Speed in Knots for Ship

FIG. 12

*Effect of Depth of Water on Propulsion.*

* No. III. appeared December 4th.

* The constants in these equations are empirical, but they are practically in the ratio of the square of the speeds for maximum wave resistance given by $P = \sqrt{\frac{4}{9}}$ and $\sqrt{\frac{4}{5}}$

in two depths of water. Both sets of data show the abnormal wave-making occurring at a critical speed, followed by a drop in resistance. At this critical speed the growth of the hollow wave around the stern is shown by the great change of trim in the "Cossack" at 22 knots. In shallow water at 21 knots there was a following wave 90ft. from the stern and 9ft. above the still water level. At 25 knots this wave had entirely disappeared and at 35 knots such transverse waves as existed were only 1ft. to 2ft. high. The angle of the divergent waves to the middle line of the ship was 21 deg. at 21 knots, declining to 17 deg. at 35 knots, the latter figure comparing with 20 deg. in 20 fathom and 15 deg. in 40 fathom at about the same speed.

In very shallow water the critical speed round which these phenomena occur is that of the wave of translation—equation 16. In less shallow water the resistance hump is given by the formula :

$$V^2 = x\, d_w \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 19$$

$x$ having the value given in Table XIV.

TABLE XIV.—*Variation of Critical Speed with Depth of Water. Value of x in Equation 19.*

| Length of ship / Depth of water | $x$. | Length of ship / Depth of water | $x$. |
|---|---|---|---|
| 4·0 | 8·6 | 8·0 | 10·7 |
| 5·0 | 9·2 | 10·0 | 11·2 |
| 6·0 | 9·8 | 12·0 | 11·3 |

When the length of the vessel is more than twelve times the depth of water, the speed for the power hump is the same as for the resistance hump, these humps being well marked. When the length is four times the depth, the hump is still apparent, the power hump coming at a somewhat higher speed than the resistance hump. The hump begins to develop at a speed which may be taken as 0·7 that given above, this factor rising a little with speed.

The increase in resistance below and apart from the above wave-making speeds, has been determined in a number of cases, but not in any systematic manner, and there are, in consequence, some unexplained differences in the results.

TABLE XV.—*Percentage Increase in Resistance in Shoal Water at Non-wave-making Speeds.*

| Ship or model. | Breadth / Draught. | Block coeffi't. | Depth of water / Mean draught at midship section. | Increase, per cent. |
|---|---|---|---|---|
| Cargo .. .. .. | 2·5 | 0·84 | 1·5 | 55 |
| | | | 2·0 | 32 |
| | | | 4·0 | 9 |
| River vessel .. .. | 4·7 | 0·82 | 1·25 | 23 |
| | | | 1·6 | 20 |
| Cargo .. .. .. | 2·32 | 0·76 | 1·7 | 26 |
| | | | 3·0 | 10 |
| | | | 6·0 | 2 |
| Cargo .. .. .. | 2·5 | 0·72 | 2·0 | 30 |
| | | | 3·0 | 12 |
| Fast cargo .. .. | 2·5 | 0·72 | 2·45 | 23 |
| "Greyhound," &c... | 2·5 | 0·70 | 2·7 | 12 |
| | | | 3·1 | 10 |
| | | | 6·0 | 2·5 |
| Fast cargo .. .. | 2·5 | 0·69 | 2·4 | 18·5 |
| River steamer .. | 6·0 | 0·69 | 6·0 | 10 |
| Liner.. .. .. .. | 2·7 | 0·68 | 1·25 | 28 |
| Scout .. .. .. | 2·4 | 0·68 | 1·5 | 28 |
| | | | 1·75 | 20 |
| Scout .. .. .. | 2·4 | 0·64 | 1·5 | 33 |
| | | | 1·7 | 30 |
| Liner.. .. .. .. | 2·5 | 0·61 | 2·0 | 20 |
| | | | 3·0 | 11 |
| | | | 6·0 | 0 to 1 |
| Fast steamer .. .. | 3·5 | 0·60 | 13 | 3 |
| Scout .. .. .. | 2·4 | 0·60 | 1·45 | 45 |
| | | | 1·65 | 32 |
| "Blenheim" .. .. | 2·7 | 0·54 | 2·3 | 23 |
| "Tauranga" .. .. | 2·8 | 0·52 | 5·5 | 5·5 |
| "Edgar" .. .. .. | 2·7 | 0·50 | 3·2 | 11 |
| Passenger vessels .. | 2·5 | 0·52 & | 2·0 | 30 |
| | | 0·54 | 4·0 | 9 |
| River steamer .. | 5·6 | 0·49 | 3·2 | 20 |
| | | | 4·2 | 12 |
| River steamers .. | 7·4 | 0·49 | 2·6 | 14 |
| | 4·0 | 0·47 | 4·0 | 12 |
| | 7·8 | 0·43 | 2·7 | 14 |
| | 4·0 | 0·33 | 2·0 | 30 |
| | | | 4·0 | 10 |
| Destroyer.. .. .. | — | 0·6 | 4·0 | 12 |
| | | | 8·0 | 4 |
| Destroyer.. .. .. | 2·7 | 0·5 | 3·0 | 12 |
| Destroyer.. .. .. | — | — | 10 | 3 |
| Torpedo boat .. .. | 3·73 | 0·45 | 3·0 | 14 |
| | | | 6·0 | 5 |
| | | | 10·0 | 0 to 2 |
| Torpedo boat .. .. | 2·8 | 0·44 | 4·5 | 12 |
| | | | 8·7 | 4·5 |

NOTE.—In many cases the tabular data are taken from diagrams of resistance or power on a speed base. The ordinates then have low values at low speed, and the smallness of the diagrams makes it impossible to be very accurate in picking off differences at these speeds. In other cases authors have given only the increase of resistance in shoal water, and for these approximate deep-water resistances have been worked out. For these reasons the results can be presented as approximate only.

A summary of a number of results on various ships and models is given in Table XV. and in Fig. 13. These are for low speeds only and are plotted on a base of $\frac{\text{depth of water}}{\text{mean draught}}$ on which the increment chiefly depends. The wildness of the spots is produced partly by the varying form characteristics and partly by the increased sensitivity of the flow. The same hull will show quite material variations of trim and resistance at the same speed, when the depth of water is less than twice the draught. There are then large eddies formed at the stern, which are being continually thrown off. This causes marked variation in resistance and, incidentally, produces large yawing moments, rendering steering very difficult. It can be said that generally :

(1) The increase of resistance remains fairly constant at all low speeds.

(2) Broad vessels show a greater increase than narrow ones.

(3) Vessels of full midship section and flat floors show greater increase than those with marked rise of floor. This was particularly noticeable in the set of forms tried by Taylor, in which the midship section coefficient was raised to 1·1. These forms had a bulge placed low down on the hull all along the midship portion, making them exceptionally flat-bottomed vessels. Their resistance was 5 to 15 per cent. higher than those in the table for the usual type of section.

(4) All the destroyer and "speed" forms can be roughly represented by the upper line in Fig. 13, and full vessels of mercantile type by the lower line,

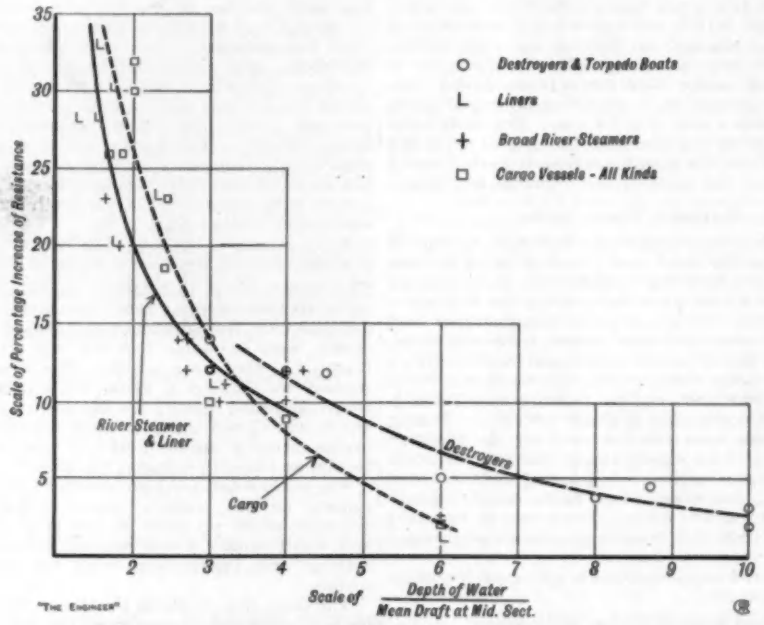



FIG. 13

*Percentage Increase of Resistance in Shoal Water, above that in Deep Water—at Non-Wavemaking Speeds Only.*

such vessels as liners and fast mercantile steamers falling between these.

(5) A wide or "duck" stern just above the L.W.L. will delay heavy stern trim, and so preserve greater clearance in very shoal water—a vital necessity for the screws.

(6) To keep the increment due to shallow water down to less than 1 per cent., the depth of water required is :

| | |
|---|---|
| For destroyers .. .. | Approximately 12 draughts |
| For cargo vessels .. .. | „ 7 draughts |

fast liners and cruisers coming between these types.

(7) When the gap between the ship bottom and the sea bottom is only a few feet, the condition of the sea bottom becomes important. If it is rough the backward flow of the water under the hull is retarded and may even cease. If the bottom consists of sand or mud, Fig. 13 gives a fair representation of its effect. With a rough bottom the increase of resistance will be greater.

(8) If a merchant vessel, with the clearance conditions of (7), is driven at wave-making speeds (V greater than $\sqrt{3\,d_w}$), her stern will oscillate vertically and be liable to strike the ground at the end of each oscillation.

*(To be continued.)*

## Worm Gearing and Some of its Applications.

By B. J. SHILLITO.*

THE following notes on the subject of worm gearing and its application to various types of machinery, including worm-driven dynamos, electrically driven grinding mills, electric printing press equipments and electrically operated rolling and rubber mills, are based on experience in the manufacture and design of these drives gained during the last twenty-five years.

The original worm gear of fifty or more years ago was essentially a slow-speed drive of low efficiency, used chiefly for intermittent duty only, and was generally single thread. The reason for these limitations was due to the following causes :—

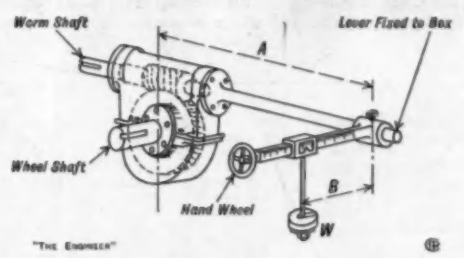
(1) Suitable materials and their treatment, for the worm and wheel had not been developed.

(2) The design and application of ball thrusts for power work was only in its infancy ; the marine type and slipping multiple-disc thrusts were practically the only forms available.

(3) The cutting of worm and wheel teeth of efficient large lead angle and of accurate profile was not understood and suitable precision-cutting machines were not available.

Subsequent developments and research have actually resulted in the production of worm gearing which is now used for very high speeds—up to 3000 to 4000 r.p.m.—and for heavy continuous duty with high efficiency, which is in striking contrast to the old worm gear referred to above.

Tests carried out at the National Physical Laboratory, Teddington, in 1930 on a well-known type of standard enclosed worm gear showed an overall efficiency of 96 to 97 per cent. with an oil temperature at the end of the continuous full-load run of 60 deg. Cent. The method adopted for testing the efficiency of this gear was due originally to Lanchester, who also developed the Hindley type worm and wheel specially for the Lanchester cars. It consists in supporting the worm gear on a set of double trunnions, so that the gear-box is free to swivel around the worm as a centre, and also simultaneously around the worm wheel, as indicated in the sketch, which is purely diagrammatic. The worm is coupled to the driving motor by a free cardan shaft, which does not restrain the swivelling of the box when the full-load driving




METHOD OF TESTING EFFICIENCY OF WORM GEAR

torque is applied ; a similar cardan shaft is used for coupling up the worm wheel shaft to the load. It will be readily seen that the tendency for the gear-box to swivel around the worm wheel as centre is resisted by the weight W acting at leverage A, which is adjustable, and the tendency of the gear-box to revolve around the worm as centre is resisted by the same weight W acting at leverage B at right angles to the lever A. It is possible to slide the weight W along the lever B by the hand wheel, and when a perfect balance is obtained in both directions, the efficiency can be read directly by means of a graduated scale fixed on the lever B, indicating the position of the weight W, which position varies according to the efficiency of the gear. If the efficiency in question is assumed to be 100 per cent., then the position of the weight W on the lever B can be easily fixed by calculation, and when the gear is running under actual full-load it is obvious that owing to the loss in the gear the weight W will require to be moved outwards, *i.e.*, increasing the leverage, and from this new position of W the efficiency of the gear can be obtained.

The self-sustaining property of worm gearing has been much utilised in connection with lifts, cranes and winches, and similar machinery. To be self-

* Chief engineer, Henry Wallwork and Co. (1930), Ltd., Red Bank, Manchester.

sustaining when stationary, the spiral angle of the worm teeth, made of ordinary mild steel, and of the wheel, made of cast iron and machine-cut, should be not more than 4 deg. to 5 deg. at the most. It should be clearly understood that such a worm and wheel, while self-sustaining with a given load when stationary, does not act as a self-sustaining brake when running; that is to say, if it be coupled to an electric motor, and the current be switched off, the worm gear will continue to run until the momentum of the motor armature and other moving parts is destroyed by the friction of all the moving parts, and this may take an appreciable time.

A self-sustaining worm gear with a lead angle of 4 deg. to 5 deg., as indicated above, cannot have an efficiency higher than about 40 to 50 per cent., and therefore it is important to consider if this self-sustaining property is really worth while, and whether it would not be preferable to use a more efficient worm gear with an automatic brake of the standard magnetic solenoid type. The loss in power associated with a self-sustaining worm gear is considerable. If the output from the gear be 5 H.P., then the input will be about 10 H.P. from the electric motor, representing 8½ B.O.T. units used per hour, and if during a year 2000 hours (six hours a day) are run under this load, the B.O.T. units paid for, and wasted, in gear friction amount to 8250 in the year, which, at 1d. per unit is nearly £35. If the gear is only running under load three hours a day, the inefficiency and loss due to its self-sustaining property still represents a cost of £17 a year. For fairly large horse-powers the self-sustaining worm gear is rapidly going out of use, but it still continues to have a useful application on the smaller sizes of winches and cranes.

### Reverse Worm Gears.

Passing from the inefficient self-sustaining type of worm gear to the worm and wheel of latest modern design, it is interesting to note that such progress has been made during the last twenty years that worm gears are now being regularly manufactured and installed, in which the worm wheel drives the worm, and gears of this type have been made by the author's firm in which the worm wheel is driven from a water turbine at 90 r.p.m., and the worm is coupled to a 50 kW dynamo running at about 700 r.p.m. During the war there were manufactured for the Ministry of Munitions about eighty sets of this type of worm gear, driving a high-speed grinding mill at over 3000 r.p.m., the worm wheel being coupled direct to the motor at 720 r.p.m. The power transmitted was 15 H.P. to 30 H.P. according to the size of grinding mill.

The essential requirements for successful operation in such a gear are :—

(1) A lead angle of 40 deg. to 45 deg.
(2) A correct pressure angle and tooth profile.
(3) A glass hard worm surface, highly polished, after being ground accurately to pitch and lead.
(4) A phosphor bronze worm wheel rim of specially hard, close-grained bronze; the ordinary mixture sand cast bronze being unsuitable.
(5) The rim and centre must be of stiff and rigid design, such that it is free from any tendency to spring or vibrate under the combined side, end, and tooth reaction thrusts.

These "reverse" worm gears, as they are often called, are in general use for driving high-speed centrifugal pumps from a slow-speed engine or motor; for driving dynamos from a water wheel or turbine; and for operating high-speed mills and machinery, where direct coupling at such speeds is not, owing to the special conditions obtaining, permissible.

The efficiency of this type of worm gear properly designed on the lines indicated above is as high as 96 per cent., including all losses. In cases where the worm speed is very high, oil bath or splash lubrication is replaced by an oil pump and a jet or jets of oil correctly directed on to the worm.

### Back Axle Worm Gears.

A wide and important application of the worm gear drive is represented by the present back axle on practically all lorries, omnibuses, and char-à-bancs. This is undoubtedly one of the most onerous duties for any form of gear drive. In the heavier vehicles the H.P. of the engine is 90 to 110 B.H.P. output, and to transmit this power to the road wheels with the bottom gear in use—*i.e.*, the slowest speed on the worm wheel—represents a torque of approximately 50,000 to 60,000 inch-pounds on the worm wheel. This gives a pressure on the teeth and on the worm thrust of about 3 tons.

An absolutely essential feature in back axle design is to meet to the fullest extent the demand for light weight, and to this end the steel maker and non-ferrous metallurgist have contributed valuable assistance, and modern electrically melted alloy steels of extraordinary purity and refinement have been evolved, which allow the imposition of stresses approaching the elastic limit with perfect safety. On the non-ferrous side have been produced bronzes and special alloys which, besides having strength closely approximate to the steels of a few decades ago, have also anti-friction characteristics.

The conditions of worm and worm wheel driving are entirely different from those present in a train of spur gears, so that tooth form and pressure angle, important as these factors are in spur gears, become vitally so in worm gear design, and have a tremendous effect upon efficiency. It will be realised that sliding and rolling motions occur simultaneously between worm and worm wheel, and to maintain that essential line contact and also to ensure a perfectly lubricated condition, the sliding and rolling must so occur as to induce a constant oil film between the teeth in contact. In badly designed worm gearing the tooth form often breaks down this necessary oil film, and literally rejects the oil from the line of pressure contact.

As regards the materials used for these heavily stressed drives, the worm wheel blanks are of special hard cast phosphor bronze, and as regards the method of casting, excellent as modern sand casting can be, there are conditions set up by the special stresses on the worm wheel teeth which cannot properly be met by the sand-casting method; consequently, the worm wheel blanks are cast centrifugally. This process produces a very dense and homogeneous structure in the casting, and no hard spots, pits, or blow-holes can occur in the tooth surface. Hence such metal has an extraordinarily high tensile strength, with a correct yield point; whilst the tooth surfaces polish and harden under load.

As an example, the following brief specification of a Wallwork back axle worm and wheel is quoted :—

The worm is of high-tensile forged nickel steel, 50 to 60 tons ultimate B.S. The worm threads are generated on specially designed thread-milling machines, with the same accuracy and "production" features as the worm wheels. The worms are carburised to produce a dense, hard surface, upon a tough, annealed centre; the threads are ground upon automatic thread grinders after hardening to give mathematically correct lead and pitch without distortion and smooth engaging surfaces.

The worm wheel teeth are produced by the hobbing process on the makers' patented gear-generating machine, which produces an accuracy of pitch, lead, and tooth profile which entirely eliminates undercutting and interference, with maximum bearing surface.

The same five points in the design specified above for high efficiency reverse worm gears apply to these back axle gears to an even greater degree, as the tooth loads are higher and the operating conditions more severe.

### Printing Press Worm Gears.

Printing press operation represents at the present time a very wide application of the worm gear drive. One of the special requirements in this trade is the slow inching round of the printing machine during the period of threading and setting up, before the main printing work begins.

The majority of printing presses are extremely large, and, from the power point of view, heavy machines, and the inching, at only a crawling speed, may require 10 to 12 H.P., about 8 to 10 per cent. of the full power at top speed. The inching speed itself being only one-fifteenth to one-twentieth of the full speed and the power small, it is not economical or feasible to attempt to carry out this "inching" by regulation down of the main motor. The standard practice is the use of what is known as a barring worm gear driven by a separate motor and coupled by a free wheel automatic centrifugal coupling to the main motor shaft. This arrangement is used in conjunction with a single handle electric controller, controlling both motors. When the inching operation is finished the next step on the controller starts up the main motor slowly, and as it gradually accelerates the main motor gently overruns the barring motor, and at a certain main motor speed the centrifugal force on the pawls of the free wheel coupling causes the pawls to fly out and disengage the main motor from the barring gear, the motor of which is then stopped on the next step of the controller. The main motor is then left to drive the machine at various speeds, obtained by shunt control in the case of D.C. main motors, and by moving the brushes where an A.C. supply and a commutating slip-ring type motor is used. For main motors of large horse-powers the electric controller does not handle the main motor current, but only a small or shunt current, which in turn operates magnetic solenoid contactors arranged with large switch contacts to deal with the heavy currents and full voltage of the large motor, and also controls the barring motor starting and stopping operations.

### Worm Gears for Rolling and Grinding Mills.

The driving of rolling and grinding mills for both hard and soft materials affords another example of the application of modern worm gearing in conjunction with a special form of electrical equipment designed to meet the special conditions. These conditions are :—

(1) Intermittent duty with heavy peak demands representing a comparatively small average load or poor load factor.
(2) A slow speed on the mill necessitating a fairly large ratio in the gear.
(3) Some device for stopping the mill quickly in case of accident to the man feeding it.

In 1914 the author devised a gear to meet these requirements. It is a combination of a high-efficiency worm and double spur gear, giving a high ratio mounted in a single enclosed gear-box of compact dimensions. The slow-speed shaft is extended on both sides so as to drive two mills, either of which can be readily disconnected if required, still leaving the other at work. The high ratio which is efficiently obtainable with this form of gear enables an A.C. motor speed of 960 or 1440 to be used. A fly-wheel on the worm shaft, with a suitable speed drop on the motor, meets the peak load demands and improves the load factor, enabling the motor to operate on a more even load, resulting in a higher operating power factor and efficiency for the motor, with a corresponding saving in the B.O.T. units used per ton of output.

To meet condition (3) the fly-wheel is provided with a powerful magnetic solenoid brake, which is normally held "off" by a shunt current from the supply mains; this current is broken by a small trip switch operated by the man either pushing or pulling a ¾in. diameter bar freely hung across the front of the mill about level with his chest, but not interfering with the feeding of the material into the mill. In a typical case a magnetic brake was guaranteed to stop the fly-wheel, motor—45 H.P.—and mill in 2½ to 3 seconds, and on test accomplished this in just over 2 seconds.

In cases where A.C. motors of moderate horse-power are used the speed drop from light load to full load of the mill is only a matter of 3 to 4 per cent., and to even-out the load effectively with this small speed drop would necessitate a very heavy fly-wheel somewhat out of proportion to the rest of the equipment. In order to avoid this disadvantage a special automatic contactor device or rheostat is supplied, which inserts resistance in the A.C. motor slip-ring circuit automatically and gradually as the load increases, thus giving a rapid drop of about 10 per cent. in the motor speed representing approximately 18 per cent. of the stored energy actually taken out of the fly-wheel. This is sufficient to meet the peak loads and results in considerable economy in the consumption of electricity as explained above, and for mills of moderate size fully justifies the cost of the automatic contactor gear.

The two outstanding features of worm gearing, as compared with any other type of gear, are its very high overload capacity and its silent running, both being valuable characteristics to all power users. The efficiency certainly drops on very heavy overloads, but this is invariably an advantage, as it results ultimately in opening the circuit breaker before any damage is done to either the motor, gear, or the driven machinery. Rope drives and trains of spur gears in the past served the engineer, but there is undoubtedly a wide field, in conjunction with moderate-speed electric motors, for a highly efficient, compact, and noiseless drive, embodying in the one gear-box the advantages of the worm drive on the high-speed motor shaft, and the advantages of cut spur gear on the slow-speed shaft, as represented by the gear described above.

*Motor H.P. Divided by Worm Wheel Speed.*

| Overall efficiency. | Ratios up to | Size of gear. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5½in. | 7½in. | 9in. | 10in. | 11in. | 12in. | 13in. | 15in. | 18in. | 20in. | 22½in. | 25in. | 30in. | 36in. |
| 93% | 12/1 | 0·017 | 0·038 | 0·06 | 0·068 | 0·09 | 0·11 | 0·13 | 0·18 | 0·27 | 0·35 | 0·45 | 0·58 | 0·9 | 1·3 |
| 88% | 13 to 20/1 | 0·016 | 0·035 | 0·055 | 0·062 | 0·085 | 0·10 | 0·12 | 0·17 | 0·25 | 0·33 | 0·42 | 0·55 | 0·85 | 1·2 |
| 85% | 21 to 25/1 | 0·014 | 0·030 | 0·050 | 0·058 | 0·075 | 0·09 | 0·11 | 0·15 | 0·22 | 0·30 | 0·38 | 0·50 | 0·75 | 1·1 |
| 84% | 26 to 30/1 | 0·012 | 0·025 | 0·045 | 0·050 | 0·068 | 0·08 | 0·10 | 0·13 | 0·20 | 0·27 | 0·34 | 0·45 | 0·70 | 0·9 |
| Maximum | motor H.P. | 1 | 1½ | 4 | 5½ | 6½ | 8 | 10 | 14 | 18 | 25 | 30 | 40 | 65 | 110 |

The complete worm gear, enclosed and running in oil, is assumed to be fitted with ball bearings, and double ball thrusts on both worm and worm wheel shafts, and to comply with the specification detailed above.

It is necessary to mention in connection with the above table that in a totally enclosed gear the tem-

perature rise is an important point, and in many cases an actual limiting factor in the rating of the gear and consequently the above constants are applicable only so long as the temperature rise is normal. The maximum H.P. given in the above table is the limit rendered advisable by considerations of heating.

## Arc-Welded Factory Building in Canada.

THE new switchboard building of the Canadian General Electric Company, at Peterborough, Ontario, is especially interesting to all users of structural steel in that it is the first building in Canada of any appreciable size to be completely fabricated and erected by the electric arc welding method. For a number of years much experimental work has been done and innumerable tests made in the General Electric Laboratories to obtain data for use in the design of arc-welded structures erected at different factories in the United States. These data have been published in the form of reports and papers, and were available for reference when designing the recently erected arc-welded structure at Peterborough.

The new building—see Fig. 4, page 626—has a floor area of 72,000 square feet. All the bays are 80ft. wide and the columns are spaced at 25ft. centres. In addition to large areas of glass on all the outside walls, further natural illumination is obtained in the low bays, and in that portion of the high bay adjacent to existing buildings by the construction of skylights which have a glass area of 10ft. by 60ft. each, spaced 25ft. apart, and having northern exposures. No glass is used in the ends of the skylights.

The 3in. wood block floor, laid on a 6in. reinforced concrete base, is sufficiently heavy to carry the lighter machines without any special foundations. The permanent walls are of brick construction with large window areas, while the temporary walls are of metal-covered wood sheathing on a steel framework with large areas of window. All temporary side steel work is bolt-connected to facilitate the removal of those walls when further expansion takes place. When completed, the building will be used for the manufacture and testing of all types of electrical switching apparatus.

The steel frame has a total weight of approximately 960 tons, and consists of steel columns of Carnegie beam sections, which carry crane girders, welded steel trusses, roof purlins, sway bracing, &c. All the trusses have a span of 80ft. centre to centre of columns, and have depths of 7ft. and 8ft. 8in. at the columns and centre panel points respectively. The heavy truss, which carries the additional weight of the brickwork of the north wall of the test section—see Fig. 5—has top and bottom chords consisting of ½ of 27in. at 160 lb. C.B. The other thirty-five trusses in the building have top and bottom chords consisting of ½ of 18in. at 67 lb. C.B. and ½ of 18in. at 52 lb. C.B. respectively. The flange of the top chord is continuous throughout, while the web was notched at the centre to permit of the necessary bending to give the required pitch to the roof. This part was then butt welded and further reinforced by a steel plate. The panel points in all trusses are at 6ft. 8in. centres.

A general view of the truss and column design is shown in Fig. 5, while Fig. 2 shows a close-up view of one of the columns between the high and low bays.

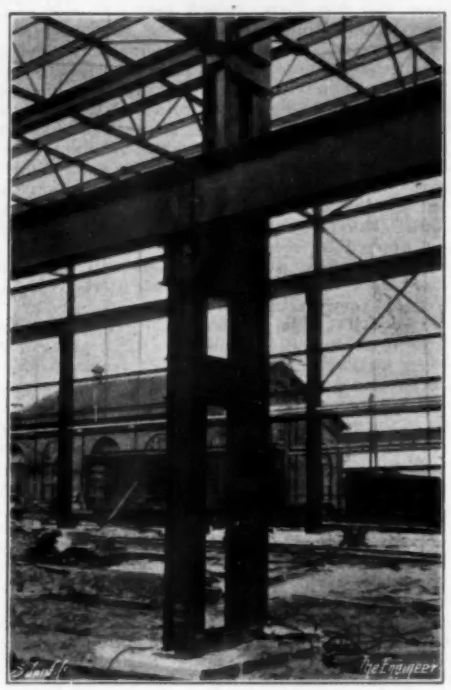


FIG. 2—TYPICAL COLUMN CONSTRUCTION

Each crane column has a cap plate welded directly to its web and flanges, and all columns have a base plate also welded directly to the column sections. Anchor bolts were connected to the column by passing them between the column web, and a short length of angle iron arranged vertically with its outer edges welded to the column web. This detail is also shown quite clearly in Fig. 2. In the centre row of columns, the column to carry the roof truss is welded between two 18in. channels, which are in turn welded to the two columns carrying the crane girders. In the other rows of columns which support but one crane girder, the roof truss column is also carried direct on the foundations.

Horizontal bracing is provided in the plane of the lower truss chords, and consists of rows of angles and Carnegie beam sections running the entire length of the building. Diagonal rods are also provided in four bays in the planes of both bottom and top truss chords. These same four bays also have vertical plane longitudinal bracing to resist crane stresses. Longitudinal struts are also provided in the plane of the truss top chords in all skylight bays. Gusset plates are welded to the truss chord flanges and longitudinal struts are bolt-connected to the gussets.

The fillet welds of triangular cross section with base and altitude generally from ¼in. to ⅜in. are subjected to longitudinal shear only, the unit shearing stresses used in design being as follows :—

¼in. by ¼in. triangular fillet, 3000 lb. per linear inch.

⅜in. by ⅜in. triangular fillet, 2500 lb. per linear inch.

½in. by ½in. triangular fillet, 2000 lb. per linear inch.

From a great number of tests which have been made the use of the above unit stresses provide a factor of safety of at least 4.

A roof load of 56 lb. per square foot, divided into 40 lb. live load and 16 lb. dead load, was used in the design. This load was considered as applied to the sloping surfaces of the skylights as well as to the flat portions of the roof. A unit stress of 18,000 lb. per square inch was used in the design of the steel.

Provision is made for two 5-ton 77ft. span bridge cranes and one 25-ton 77ft. span bridge crane, with a 5-ton auxiliary hoist. The 25-ton crane has a hook lift of 35ft., while one 5-ton crane has a lift of 16ft., and the other a lift of 55ft. All bridge crane girders are Carnegie beams generally supported directly on top of the crane column. The only exception to this is in the case of the 5-ton 55ft. lift crane in the test portion of the high bay, which travels directly over the 25-ton crane and which is supported on brackets attached to the roof columns.

In the skylight framing eighty-eight small trusses were required. The lower chords of these trusses are supported on short pedestals at sub-panel points on the main trusses. These pedestals are of just sufficient height to compensate for the pitch of the top chord of the main trusses and place the bottom chords of all skylight trusses in a common plane. The top chords are inclined sufficiently to provide the necessary height for windows and framing. Top and bottom chords of skylight trusses are of Tee sections, with the vertical post of channel sections, all other members being composed of angles. These skylight trusses are erected at 20ft. centres and are cross-braced with diagonal rods.

That excellent progress was made in the erection of the steel work is indicated by the fact that only three weeks were required from the erection of the first column till the completion of the work. No great difficulties were experienced during erection, "though," comments the company's plant engineer, "it would appear that erection would be expedited by the more liberal use of bolted connections instead of clamps. While this is especially true of members which require punching from other reasons, it would also appear that the time saved in erecting with bolt connections properly designed for erecting purposes only, instead of clamps, would more than justify the punching of these holes, even though this work were done by the field forces just prior to erection of the members."

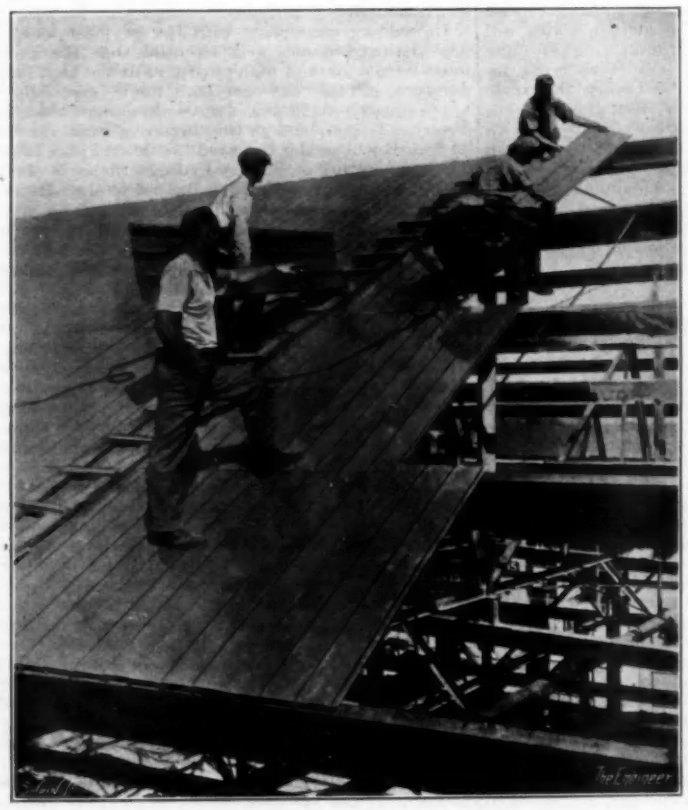


FIG. 1—WELDING THE ROOF DECK

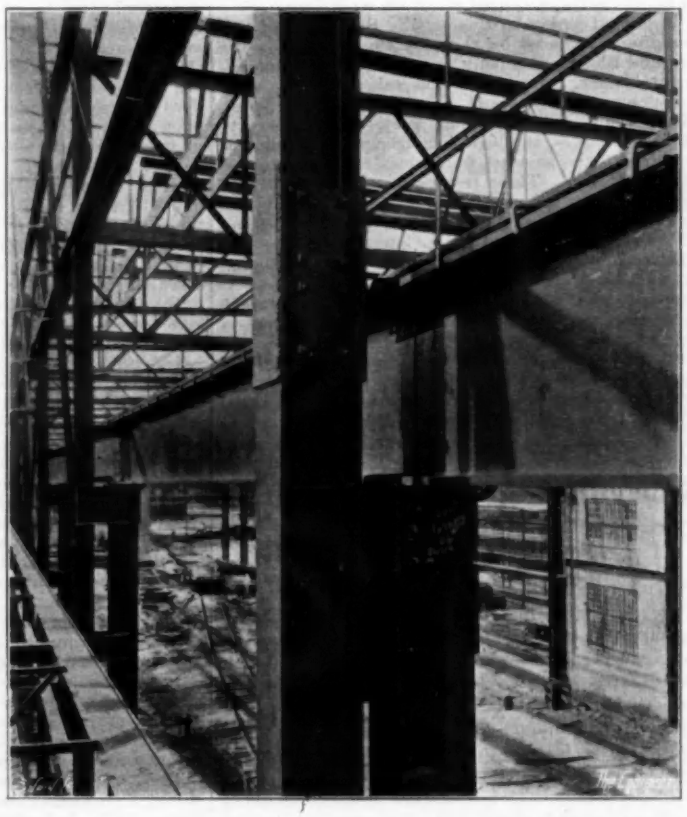


FIG. 3—CRANE GIRDER SEAT AND COLUMN SPLICE

A "holorib" steel deck electrically welded to the purlins was used on this building. This deck is made in sheets, 18in. wide and long enough to lap 3in. over the purlins. These sheets telescope together this 3in. at the end to provide for expansion, while at the other end two ribs per sheet are welded to the building purlin. Fig. 1 shows a welder in the process of welding the roof deck. The erection of approximately 800 squares of this deck required about four weeks' time. The roof deck is covered by two ½in. layers of insulation on which is laid a 15-year Johns Manville asbestos felt roof.

The use of welding on this building resulted in (*a*) a considerable saving in steel, (*b*) in a steel frame of unusually good appearance as a consequence of the almost entire absence of gussets, and (*c*) in the elimination of the noise of riveting. Because, however, of the adoption of a lighter roof deck than was originally intended, and of the early decision to adopt welding methods, no exact figures are available to indicate any saving due to welding. On the 600 tons of steel which passed through fabricating shops, as many as seven welders were used, each employing a single-operator motor generator welding set of Canadian General Electric manufacture. The field work was done on the steel work by two welders, while a third welder was employed on the roof deck. All field welding was done with portable welding sets. In the fabricating shop the trusses were assembled on timber skids, the diagonal and vertical members clamped to the chords in their proper location and all the joints welded. All trusses were assembled and welded lying flat on their sides.

The eighty-eight skylight trusses were assembled by clamping the members together on timber jigs in the field, and all were welded complete before erection started. These trusses were all nearly alike, so that, once the jigs were laid out, no changes were needed till the completion of the work. No overhead welding was permitted either in shop or field work. No Canadian General Electric inspector was placed in the fabricating shops during the progress of the work, though all welds were inspected on the arrival of the steel work on the site. Welds on both the shop and field work were found to be uniformly good, and in all cases they erred on the side of larger sections and longer welds than was called for on the drawings.

Some 360 tons of steel were shipped directly from the rolling mills to the site. This steel was delivered cut to proper lengths and the necessary punching was done by the field forces before starting erection operations. This steel work was generally for use as crane girders, purlins, skylight trusses or longitudinal struts. Field forces were engaged on this work about one month before starting erection. The shop fabrication required about six weeks' time.

As noted earlier in this article, the design of this building was based on the practice adopted by the General Electric Company as a result of much experimental work. Great care was taken to have only competent welders, both on shop and field work. Each welder before starting work was required to weld test pieces, the breaking strength of which was required to be at least four times the unit stresses used in design. These test pieces were also welded periodically as the work progressed, and, in addition, the welding was subjected to continual inspection. It is interesting to note that the lowest breaking stress obtained by any welder working on this building was 12,250 lb. per linear inch for ¼in. by ¼in. fillets Other results up to over 14,000 lb. per linear inch were obtained. It is also interesting to note that on the periodical field tests, which were made on tension test pieces only, an average ultimate strength of between 53,000 lb. and 54,000 lb. per square inch was obtained, while in several cases the break occurred in the parent metal rather than in the weld.

## Some Practical Notes on Jointing Aluminium.

By A. J. T. EYLES.

ALUMINIUM and aluminium alloys have become a very important material of construction and fabrication in the aircraft, automobile, electrical, chemical and general engineering industries, and this has necessitated the development and perfection of various jointing processes in this metal. Since the jointing of aluminium and aluminium alloys forms so important a feature in modern transport and all kinds of engineering and machinery construction, a few notes from one who has spent upwards of twenty years in research work, involving the investigation of various methods for making joints in the metal for the assembly of structures and the repairing of fractured or broken aluminium and aluminium alloy products and components, should be of practical value and general interest.

### SOLDERING ALUMINIUM.

In the early days of the aluminium industry, the production of a satisfactorily soldered joint in the metal was considered almost an impossibility. To-day efficient soldered joints are produced in everyday practice in many factories, and it can be definitely stated that, allowing reasonable care, aluminium can be soldered.

To those conversant with the process of soldering metals, it is well known that there is no solder—or soldering flux capable of attacking the oxide at a temperature well below the melting point of the metal, 658 deg. Cent.—which acts with aluminium, or even aluminium alloys in the same way as do ordinary soft solders operate with brass, copper, nickel, and tin-plate. Indeed, it is incorrect to speak of soldering aluminium—especially with the relatively high melting solders—as an ordinary tinsmith means soldering—with a hot copper bit and a solder that will flow and follow it speedily. Aluminium and aluminium alloys are not soldered that way. A higher degree of heat is required to solder aluminium than can be conveyed by means of the ordinary soldering "bit." Moreover, the low melting point solders are best applied by mechanical means, as there is no satisfactory flux available which will effectively attack the refractory layer of oxide at the comparatively low temperature of working.

It is well known in metal working plants that all forms of soldering require the application of the proper amount of heat in order to make a strong and permanently sound joint, and that the temperature required varies with different metals, irrespective of the solder or flux used. In many cases failures in soldering aluminium and aluminium alloys can be traced to incorrect regulation of the heat used in making the joint.

In considering this question, it is essential to remember that three different types of soldering can be used, namely, soft, hard and reaction soldering. The main obstacles to an easy and permanent soft soldering process are: (1) The refractory oxide film, which is intensified at soldering temperatures and prevents ordinary low-melting solders from alloying with the light metal, and (2) the thermal conductivity and high specific heat of aluminium which renders local heating to the alloying temperature a tedious operation, more particularly as the size of the product or component worked on increases. Thus the heat is conveyed from the soldering tool, and solder so rapidly that they become chilled quickly, and, therefore, the solder does not become sufficiently liquid to flow readily.

In this process the solder melts at a comparatively low temperature, and it is this type of work which has given rise to the widespread view that aluminium is difficult to solder. The reason is that no satisfactory flux is available which will attack the oxide at the low temperature of working, so that the oxide must be removed by mechanical means. After a preliminary cleaning the metal is heated until the solder melts upon it. The molten solder will not adhere, but it can be made to do so by scraping through it with a clean steel scraper to break up the oxide film. Once the film is broken the oxide does not reform under the solder, and alloying takes place. When the surface is fairly well covered with molten solder, the adhesion is improved by rubbing with a wire scratch brush, while the solder is still molten, thus breaking up any remaining traces of oxide. After such "tinning," the parts can be soldered together in the ordinary way. Fluxes are sometimes supplied with these solders, but they consist largely of stearin or resin, and are of little assistance.

To test the efficiency of soft soldered joints accelerated methods are usually practised, and this method of testing is claimed to be equivalent to two years' ordinary exposure. One method is to boil a soldered joint for about half a dozen hours in water that is slightly salt. Another test to which a soldered joint can be subjected is that of playing steam on it for a few hours. Soft soldered joints which have the appearance of being satisfactory and which are apparently mechanically strong—within the limits of the strength of the solder—disintegrate when exposed to steam. Another good method of testing aluminium soldered joints is to make up a few flat-lap joints in sheet aluminium of thin gauge and boil them in distilled water. If a joint stands up to that boiling for, say, 50 hours, without disintegration, it is considered a good solder.

Hard soldering provides an efficient means of jointing aluminium products or components when it is inconvenient or uneconomical to adopt welding methods. Thus, in aluminium hollowware production, component-parts such as kettle and teapot spouts are currently hard soldered to the main body, and this method gives the utmost satisfaction.

The hard solder consists of an alloy of aluminium having a melting point between 500 deg. and 600 deg. Cent. Many such alloys exist, but the silicon alloy, containing 10 to 13 per cent. of silicon, is the best. The oxide is removed by means of an alkaline halide flux, such as is used for welding aluminium. At the temperature at which the soldering is carried out the flux is melted and rapidly attacks the oxide, permitting the melted solder to come into contact with clean aluminium and to alloy with the metal. In carrying out this process an atmospheric gas blow-pipe is used as heating medium, but, apart from this and the higher temperature required, the process does not differ from the ordinary soldering of brass. The flux is applied on the end of the solder strip or bar, which is melted up and flows readily, soldering the parts together. Silicon alloy solder in the form of a tube with the flux contained inside can be obtained from certain manufacturers.

Hard soldering aluminium with a silicon alloy solder is a process that can be recommended for ease of application, permanent tightness and strength. Unlike soft soldering, a hard soldered joint is capable of withstanding the action of boiling water or steam.

It may be worth while to make reference at this stage to a recently developed process known as reaction soldering, which gives very satisfactory results.

The solder used is a chemical mixture which is spread on the aluminium parts to be jointed and heated by a gas blow-pipe flame to about 200 deg. Cent. A chemical reaction takes place which results in the deposition of pure zinc in a molten condition on the surfaces to be joined. The zinc flows freely between the edges and alloys readily with the aluminium, forming an excellent joint. Such joints are much more permanent than joints made by the ordinary soft soldering process.

### THE WELDING OF ALUMINIUM.

Among the methods which are employed for jointing aluminium and aluminium alloys there is none more generally satisfactory than autogenous fusion welding by means of the oxy-acetylene or oxy-hydrogen flame and the electric arc. Fusion welding of aluminium joints obviously makes a much stronger and more intimate union than soft or hard solders, there being no interposition of any other metal. The welds have therefore the same characteristics as the aluminium of which the products or components are made.

The art of welding requires skill and training, whatever may be the metal treated; aluminium, because of its unique characteristics, requires a technique somewhat different from that used with steel and cast iron, but actually aluminium is one of the most readily weldable of all metals, and the main difficulty likely to be met by a beginner in the art of welding is the choice of a correct speed, since the rate of welding is quicker with aluminium than with mild steel, brass, copper, &c.

The points to be noted in welding aluminium are the rapid oxidation of the metal; its high rate of expansion and contraction, being approximately twice that of steel; its high thermal conductivity; its high specific heat, being 0·212, which is more than twice that of copper; its relatively low fusion point; its comparative weakness in tension, especially at high temperatures; and in welding, particularly aluminium alloy castings, the chances of distortion or warping making it somewhat difficult to keep the work in alignment.

In welding aluminium with the oxy-acetylene or oxy-hydrogen flame it is essential that the gases must be in a state of high purity, as at the high temperature of the oxy-acetylene flame especially—approximately 3480 deg. Cent.—aluminium tends to absorb nitrogen, and if this impurity exists in the oxygen it will render the weld brittle and unreliable. The temperature of the oxy-hydrogen flame is about 2400 deg. Cent., and its use is limited to comparative thin-gauge material—say, up to ¼in. The oxy-acetylene flame is therefore the most satisfactory of all gas flames for the stouter and heavier sections.

It is known to those who have undertaken jointing aluminium by autogenous fusion welding that when two pieces of the light-weight metal are to be welded together at their edges the melted portions do not flow together properly, as in the case of iron or mild steel, where the melting point of the oxide is below that of the metal. The molten aluminium spreads in globular form under the influence of the welding flame. These metallic globules consist of pure aluminium within a coating of alumina—oxide of aluminium—which has great power of resistance to the flame and on cooling the edges of the metal remain unjoined; hence the need of a good flux to dissolve and reduce the layer of oxide and allow the fused metal to flow satisfactorily together. However, this layer or film of oxide can be broken up by mechanical puddling. In this process the welding operator usually uses a steel rod with a flattened end so as to scrape and agitate the molten metal at the moment of melting, thereby allowing the metal to coalesce. When puddling methods are employed there is a possibility that some oxide, which has a higher specific gravity than the metal, will remain in the weld, interfering with its strength, and will lead in time to disintegration. In other words, a welded joint in aluminium without the use of flux never presents perfect homogeneity. The use of a flux is very much more satisfactory. It also obviates the use of puddling tools or scrapers. The accompanying table gives the compositions of several fluxes commonly used for aluminium welding, but most of these are patented compounds.

There are various methods of applying aluminium fluxes when making a weld. The flux may be applied in paste form to the surfaces to be welded, or the parts may be heated and powdered flux placed on the weld joint, or the end of the welding rod may be heated and dipped into the flux, which readily adheres to it in the form of a thin varnish; the latter method is the safest and the best. It should be unnecessary to apply more flux to the weld joint than that which

coats or varnishes the rod for a distance of 4in. or 5in. Too much flux is harmful as well as wasteful. The gradual melting of the rod will automatically feed flux on to the weld just where it is required and at a uniform rate. In other words, the flux will flow ahead of the welding flame and prepare the metal. The powdered fluxes should be kept free from dust and dirt, and preferably in air-tight containers, as they are slightly hygroscopic. Liquid or pasty fluxes can be reduced to proper consistency by mixing with alcohol or clean water, but for preference a powdered flux should be used when practicable.

*Fluxes for Aluminium Welding.*

| Substance. | Flux I., per cent. | Flux II., per cent. | Flux III., per cent. | Flux IV., per cent. | Flux V., per cent. | Flux VI., per cent. | Flux VII., per cent. | Flux VIII., per cent. | Flux IX., per cent. | Flux X., per cent. |
|---|---|---|---|---|---|---|---|---|---|---|
| Potassium chloride | 83 | 79 | 62·7 | 62·5 | 60 | 56 | 45 | 33·4 | 4·2 | — |
| Sodium chloride | 17 | 16 | 12·5 | 32·5 | 12 | 6·5 | 30 | — | 79·2 | 86 |
| Lithium chloride | — | — | 20·8 | — | 24 | 23·5 | 15 | 33·3 | 7·4 | — |
| Sodium sulphate | — | — | — | — | — | 4 | — | — | — | 14 |
| Potassium sulphate | — | 5 | — | 5 | — | — | — | — | — | — |
| Sodium bisulphate | — | — | 4 | — | — | — | — | — | — | — |
| Potassium bisulphate | — | — | — | — | 4 | — | 3 | — | — | — |
| Sodium fluoride | — | — | — | — | — | — | — | 33·3 | — | — |
| Potassium fluoride | — | — | — | — | — | — | 7 | — | — | — |
| Cryolite | — | — | — | — | — | 10 | — | — | 9·2 | — |

### Welding Material.

The welding material—usually in the form of a rod—for aluminium sheet and sections from pure metal should be of approximately the same purity as the metal being welded. For aluminium alloys the welding material should be of approximately the same composition as the alloy to be welded, in order to produce a uniform welded joint. The stresses due to contraction are absorbed by the weld metal without any ill effects. Weld metal from silicon welding rod should not be heat treated at temperatures above 500 deg. Cent. Flux-filled rods for pure aluminium and aluminium alloy welding are obtainable from manufacturers in various diameters and they are very advantageous for certain welding jobs, particularly for use on vertical welds in tank construction and transport vehicle panel repair work *in situ*.

Preheating is desirable in welding aluminium and aluminium alloy castings to prevent severe expansion and contraction stresses, and also to conserve costly gases. Experience teaches that the preheating should not be less than 250 deg. Cent. and not above 400 deg. Cent. Higher temperatures yield no advantage. Welding operators can generally tell when the correct preheating temperature has been reached by rapping the casting. Another test is to apply dry pine or deal sawdust. When the correct temperature has been reached the casting will begin to char the sawdust. This latter method is the safest, as it enables the welder to tell at a glance whether the work is heating uniformly. In the case of castings of complex shapes or castings that vary greatly in thickness it is advisable to support the metal beneath the joints to be welded and the adjacent areas with steel sheet bent to fit the casting and covered with asbestos. The sheet steel, in turn, may be blocked up with fire-brick to provide the requisite support when the metal is hot. During the preheating process the casting should be covered with asbestos sheeting to keep the temperature as uniform as possible. The asbestos should not be removed during the welding operation, except as it is necessary to effect the weld. Many aluminium products and components can be welded successfully without preheating, as, for instance, small pieces that have broken off at a point some distance from the main part of the casting.

In the actual operation of welding careful regulation of the blow-pipe flame is essential, and the metal should be heated slowly if the work is of such a nature that unequal expansion is likely to be harmful. A neutral flame gives the best speed and economy. Further, an excess-oxygen flame will cause rapid formation of aluminium oxide, which is detrimental to efficient aluminium welding. The blow-pipe should be inclined at an angle of 40 deg. to 45 deg. from the plane of the weld, so that the force of the welding flame will not blow holes in thin sections of the metal. The flame should be so applied that both sides of the weld joint will be heated and melted equally and simultaneously. With joints of unequal sections it is thus necessary to direct the welding flame more against the heavier part. Once actual welding has commenced it should progress to completion without interruption. Sheet aluminium welds should be expeditiously executed from the moment the first fusion is obtained. The speed of welding is not uniform, but accelerates as the weld proceeds.

After the weld is completed the work should be allowed to cool gradually, especially in the case of complicated aluminium alloy castings, so that all parts shall contract uniformly. A good plan is to cover the hot casting completely with asbestos or sand, which has previously been warmed for fifteen to twenty hours. This treatment not only removes the possibility of internal stresses, but often results in a definite improvement in the mechanical properties of the metal itself.

The completed welds and the surrounding metal must be thoroughly cleaned by washing and brushing with plenty of hot water to remove all traces of the flux, which would otherwise continue to produce a chemical action on the metal that would result in harmful corrosion. In some welding plants the welds and the adjacent areas are washed with a 5 to 10 per cent. solution of sulphuric acid. After this treatment the work should be thoroughly washed in plenty of clean water to remove any of the acid solution that may be left. The welds may also be cleaned by directing a steam jet on them. This method has advantages for removing all traces of the flux from corners, crevices, &c.

Whenever practical, it is advisable to hammer the welded areas. Hammering tends to relieve the contraction stresses set up during the cooling of the weld and adjacent metal. Hammering may not be sufficient to break down the cast structure in the weld completely, but it will tend to eliminate the cast structure to some extent and thus produce a more nearly uniform condition throughout the work. Hammering will also tend to obliterate any surface porosity that may be present in the weld, and make the metal harder.

### Cast Welding.

The art of cast welding, or burning, sometimes termed "burning-on," is often carried out at the present time in foundries and engineering works where modern welding methods are not employed, and is mostly used for jointing fractured aluminium alloy crank cases of motor vehicles and broken parts of machines.

Small pieces that have broken off a large casting are sometimes reconditioned by this process, which is also applied to repairs that must be effected as soon as possible. For such work this method of cast welding or burning is generally considered economical, especially where a replacement requires much machining. Briefly, the process consists in pouring molten metal of approximately the same composition as the work over the parts to be joined until they are fused together, stopping the flow of metal and allowing it to cool, superfluous metal being afterwards removed by chipping and grinding.

With aluminium alloy castings, the essentials for good work are: Properly prepared moulds in which the molten metal may be poured; the parts to be firmly secured in order to avoid distortion during pouring; provision that the initial pouring may run out by suitable gates, after passing over and heating to fusing point the surfaces to be welded, an excess of metal being allowed; the areas where the weld is to take place must be clean, also roughed; and provision of tall gates to provide a pressure that penetrates the oxide film. The pouring should be methodically done to ensure a strong weld.

It is not claimed by the author that a burn-on is the best method of repairing or jointing broken aluminium alloy products, but it can be said with truth that it is an effective and economical method to employ in foundries where modern welding equipment is not available, and in cases where a quick repair is required.

### Pressure Welding.

Pressure welding is often employed for the jointing of aluminium rods and wires up to about 1¼in. in diameter; bars also, and with care aluminium tubes of various thicknesses and diameters, can be jointed by pressure welding. The process depends upon the fact that aluminium has a comparatively low melting point, so that the end of a rod, tube, or bar of reasonable dimensions can be raised to the melting point by an atmospheric gas blow-pipe or a paraffin blow-lamp flame. As the end of a bar or rod is heated the surface oxidises and becomes coated with a tough skin of oxide which is sufficiently strong to retain the molten metal. In employing pressure welding for the jointing of rods and bars, the two ends to be welded are held about ¼in. apart in the blow-pipe or blow-lamp flame until they just begin to run, a point which is easily recognised because the sharp edges of the rod or bar begin to round off. The heating medium is then removed, and the two rods or bars are pressed together. The pressure employed bursts the skin of oxide, which is squeezed out with the semi-molten and plastic metal to form an irregular collar around the joint. Within this collar a homogeneous union of the metal of the two pieces takes place, and when the joint is cold the collar of metal can be trimmed off with a chisel or grinding. A good illustration of aluminium pressure-welded rods is shown on page 122 of THE ENGINEER, February 4th, 1927. In cutting off the rods to length prior to welding, an allowance in length about equal to the diameter of the rods should be made to provide for the metal to be squeezed out.

### Hammer Welding.

Welding aluminium under the hammer was the first method adopted for jointing the light metal, and the credit of having welded aluminium is supposed to be due to W. C. Heraeus, of Hanau, near Frankfurt. The process was described as follows in the *Electrochemist and Metallurgist*, March, 1901:—"The operation consists in cleaning the surfaces to be joined, laying them together and heating carefully to the temperature at which the metal commences to soften, keeping at that temperature, and meanwhile hammering together to a perfect weld. It is important that the temperature be kept constant; if the temperature rises too high, the metal becomes short or granular, and commences to oxidise—a condition which renders the weld useless." Not only is the process of interest from an historical viewpoint, but also from the fact that it is a form of true welding. Modern practice shows that welding aluminium and some of its alloys which can be handled in a more or less pasty state is practicable under the hammer, although it is admittedly a difficult and delicate operation, because it is not easy to maintain the temperature at the correct value during the operation of hammering so as to work out the oxide completely.

In hammer welding aluminium, the edges of the metal are usually rounded, cleaned, overlapped, and then heated to about 400 deg. Cent., followed by judicious and speedy hammering. In practice, it is found that unless the number of hammer blows is sufficient, the weld will not be satisfactory. When only a few hammer blows are dealt, particles of oxide invariably remain in the weld, but when many blows are judiciously delivered the oxide is practically eliminated. Needless to say, highly skilled workers are necessary to effect good hammer welds on aluminium.

### Electric Welding.

During the past few years extensive investigations of the application of electric welding, including resistance welding and arc welding to aluminium and aluminium alloys, have been conducted in Great Britain, United States and European countries.

As a result, electric welding processes have made great advances in jointing aluminium and aluminium alloys. The electric arc process, for instance, has been developed to the point where, within certain limits, it may be considered practical as a production method. The equipment required for arc welding aluminium products and components is practically the same as that used for similar work on other commercial metals.

The electrodes used are usually of the flux-coated type, although it is possible to effect good welds in the light metal when using bare electrodes and a good welding flux as used in the gas welding process. Experience shows that the secret of successfully arc welding aluminium and aluminium alloys depends upon the use of a proper flux—as in gas welding. Reversed polarity, a very short arc, and comparatively low amperages are used. The exceptionally high temperature of the arc, together with the short flame, is an important factor in developing improved physical properties of arc welds in aluminium, as compared with oxy-acetylene or oxy-hydrogen welds. The high temperature produces rapid fusion in the aluminium work and the electrode, while the short arc localises the heat. These properties greatly reduce the width of the heat-affected area in the sheet or plate, with a corresponding increase in weld efficiency.

Where applicable, the arc welding process will be found to be more economical than either the oxy-acetylene or oxy-hydrogen process. The initial costs of arc welding and the price of flux-coated electrodes are both fairly heavy, but this extra initial cost is more than balanced and an all-round saving obtained from the big reduction in operating costs and the relatively low cost of electric power compared with oxygen, acetylene and hydrogen.

Electric resistance butt welding of aluminium differs little from the ordinary practice. A large current is supplied at low voltage; the terminals are clamps or vices, which securely hold the rods or wires to be welded. When the latter touch the electric circuit is completed, thus allowing the current to flow through the butted joint, and heat is generated until the melting point is reached, and under the applied pressure the rods or wires are fused together. In works were much butt welding of rods or wires is done the whole of the operations is automatic, there being a definite current, pressure and time for the complete operation. By this method repetition work of uniform quality can be effected more speedily than in ordinary blow-pipe flame welding.

Electric spot welding of aluminium has been developed during the past few years to a stage where it is used in regular production in the fabrication of aluminium articles. When spot welding can be used in place of riveting, it affords an economical means of jointing aluminium sheet and strip material.

In electric spot welding of aluminium, the best results are obtained by using special electrodes tipped with an alloy material, such as copper and tungsten. This alloy, owing to its increased resistance,

enables a higher surface resistance to be obtained between the welding points and the material to be welded, which aids in obtaining the necessary welding temperature. Also, owing to the fact that it is a poorer conductor of heat than ordinary copper, it also assists in preventing the heat generated at the point of weld from being dissipated through the copper electrodes as rapidly as would be the case if these alloy tips were not used. In practice, it is also found that it is necessary to use only about one-third to one-half of the pressure on the electrodes as is used in spot welding iron or steel.

A recent development consists in having chromium on the contact surfaces of the electrodes. The tips of the electrodes may either be plated with chromium or a piece of chromium may be inserted in the copper tips. With such tips, about 2000 spot welds can be made with one pair of electrodes before replacing or redressing is necessary.

The aluminium surfaces to be jointed by spot welding must be clean and free from dirt or heavy oxide coating, which would prevent metal-to-metal contact. Dirty aluminium can be cleaned by abrasion or dipping in a 20 per cent. (by weight) caustic soda solution, neutralising in a 15 per cent. (by volume) nitric acid solution, and then thoroughly washing in hot water. The tips of the electrodes must also be kept clean and properly shaped.

The three factors of importance in electric spot welding aluminium are: Time, current and pressure. Judicious adjustment of these factors will allow of making a satisfactory spot weld under circumstances which seem most unfavourable. The current density and mechanical pressure should be the lowest that will produce a good spot. The parts to be spot welded should be clamped together in such a manner that good contacts are assured in making the welds. It is obvious that the efficiency of a spot welded joint, as in riveting, will depend on the number of spots. About four distinct spots to the inch can be made where necessary. Regarding the pitch of the spot welds when welding aluminium sheet or plate, the character of the work must be the determining factor.

In the accompanying engravings—Figs. 1 and 2—

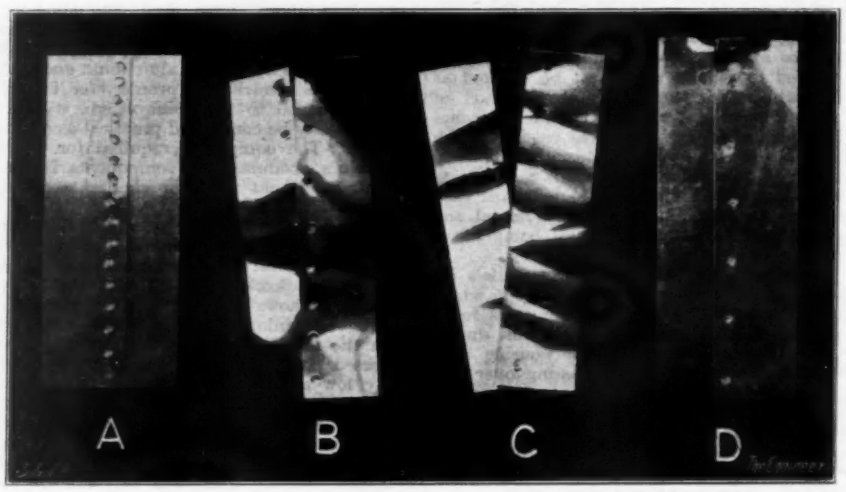



FIG. 1—EXAMPLES OF ALUMINIUM SPOT-WELDING

are shown examples of aluminium spot welding done on standard "Pontelec" spot welders. The actual welding time in each case was approximately three-fifths of a second. In Fig. 1 at A is shown a good spot-welded seam on aluminium sheet 0·028in. thick, approximately four spots to the inch, and at

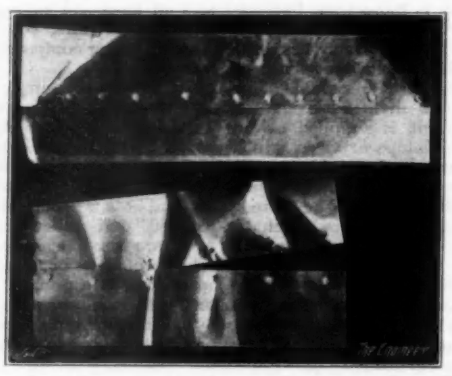


FIG. 2—SPOT-WELDED ALUMINIUM SHEET

B and C the results of destructive tests for weldability on aluminium sheet 0·028in. and 0·036in. thick. In the tests the spots were completely torn out of one sheet. The spot-welded joint D was on aluminium sheet 0·064in. thick, with spots at about ¾in. apart. Fig. 2 shows a satisfactory weld on aluminium sheet 0·024in. thick. The ability to tear the sheet indicates cohesion and the high quality of the spot-welded joint.

Electric seam welding is a development of spot welding. In seam welding, two pieces of aluminium sheet are joined together in an uninterrupted lap weld under one or between two rotary disc electrodes. It is essential that the edges of the sheets be perfectly clean and free from dirt, grease, heavy oxide coating, &c., as impurities offer a high resistance to the passage of current and necessitate a higher electrical pressure, with the result that when foreign matter is penetrated a rush of current takes place owing to the drop in the resistance, and the metal may become impaired.

Numerous tests on seam-welded aluminium joints show that this method is not very satisfactory where high strength is required. In a seam or joint made by this process, the presence of the oxide can be clearly traced along the plane of union. It is extremely difficult to eliminate the oxide film. Electric seam welding of aluminium or its alloys should, at the present time, be looked upon as in the experimental stage.

### RIVETING ALUMINIUM.

Riveted joints in aluminium and aluminium alloy sheets, plates and sections are remarkably efficient if the riveting is judiciously done. It is sometimes stated that aluminium cannot be riveted so well as other industrial metals, on account of the softness of the metal, which allows the rivets to work loose or draw out, thus giving rise to leakage, especially when subjected to excessive vibration, temperature variations, &c. Such statements are inaccurate, for by continued rolling in the manufacture of aluminium and the age-hardening of certain aluminium alloys, hard rolled sheets and plates are obtainable. Admittedly, aluminium does not harden to that degree of hardness obtained in steel. However, the more important types of riveted joints are as applicable to aluminium and certain aluminium alloys as to most other metals.

Some few years ago the author assisted in the construction of a large number of all-metal railway passenger coaches, 63ft. 4½in. long, 12ft. 4½in. in height. The roof plates and panels consisted entirely of aluminium sheets. Nos. 16 and 14 gauge (0·064in. and 0·080in.). Many of the aluminium sheets were formed to the different curvatures required, and afterwards riveted to angle, tee and channel aluminium alloy and steel sections.

In the construction of each coach approximately 10,000 aluminium rivets were used. Illustrations of these all-metal railway coaches appeared in THE ENGINEER, February 25th, 1916. From a study of aluminium riveting after fully fifteen years of service on the above electric railway coaches it can be truthfully said that all riveted joints are still in excellent condition, despite their exposure to average weather conditions in a fairly severe industrial atmosphere.

The selection of aluminium rivets should be determined by the work on which they are to be used. Diameter and length are alike important, for rivets that are not of the correct diameter and length will result in unfilled holes, in eccentric or unfilled heads, or in difficulty in driving, any one of which conditions may produce imperfect and inefficient joints. Riveting, if done rightly, is an economical and satisfactory method of jointing aluminium and aluminium alloy sheets and sections in aircraft and large construction work. The riveting is invariably done cold, and the rivets should be of the same metal as the sheets and sections to be joined in order to avoid electrolytic action.

Strong aluminium alloy rivets, such as duralumin, lautal, &c., for riveting sheets of similar material may be obtained in the annealed condition and then be "normalised" or finally heat treated, and if stress on them is not severe it is possible to use them in the finally heat-treated condition. Should any signs of cracking be observed in the rivet head on hammering up it is necessary to heat treat the required quantity before riveting further. Immediately after quenching, the rivets are soft and can readily withstand the deformation of riveting, and after the work has been done the rivets will then age-harden *in situ*.

An important factor in riveting aluminium sheet and thin sections is that the rivets must have ample clearance in the holes, to allow for spread in riveting. A greater overlap than in the case of sheet steel should be arranged, otherwise the extension of the metal will cause an irregular or wavy edge. Holes should be punched slightly undersize and reamed to correct size where high stresses are encountered. The amount of metal that should be removed by reaming will vary with the metal thickness and diameter of the hole.

Regarding the pitch of the rivets, the character of the work is the determining factor. But in general the pitch should not be less than three and a-half times the rivet diameter. It is obvious that if a riveted joint is to be leak-proof the rivets must be closely spaced. Large-headed aluminium and aluminium alloy rivets are desirable so as to obtain the maximum bearing surface.

When riveting aluminium it is desirable that the head of each rivet should rest solidly on suitable tools, and whenever practicable a good plan to adopt is to use the thickest part of the tool for riveting operations in order to gain solidity. When riveting long seams or joints the work should be assembled temporarily with bolts and the rivets driven at random instead of progressively from one end to the other. The purpose of the bolts is to prevent the rivet holes getting out of coincidence and to hold the sheets in close contact.

Riveting is usually done by hand or small riveting machines on aluminium sheet or sections up to ¼in. thick, also on aluminium rivets up to ¼in. in diameter, but above these dimensions the riveting is usually done in squeeze type riveters or by pneumatic hammers.

Fig. 3 illustrates a riveted petrol tank jointed by

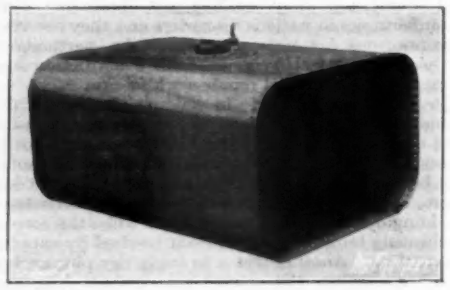


FIG. 3—RIVETED ALUMINIUM TANK

the De Bergue patented countersunk riveted process. The tank is fabricated from duralumin sheet No. 20 gauge, 0·036in., with a single line of $^{5}/_{32}$in. diameter rivets at ⅝in. pitch. The immense advantage obtained by this process is that the sheets or plates are thoroughly interlocked at each rivet, thus making the riveted joint eminently suitable for any structure or product which is subject to stress.

Fig. 4 shows a new riveting machine developed by the Hanna Engineering Works, of Chicago, for driving aluminium and duralumin rivets in aircraft construction. The machine is shown heading over rivets in a bulky frame. It has a reach of 48in. and a 10in. gap permits entering work with comparatively wide flanges between the jaws for riveting operations in the central portion of the web. When the ram is operated under an air pressure of 100 lb. per square inch and with a die stroke of 1½in., ¼in. diameter rivets can be driven easily. The possible ram speed is 60 strokes per minute. The pressure exerted by the ram is predetermined and is uniform for a considerable portion of the stroke, resulting in a correctly driven rivet regardless of variations in the thickness of the parts.

With the machine arranged with the dies placed vertically and the ram cylinder on the underside as shown, the rivets are headed over on the underside of the work. The rivets may be inserted well in advance of the riveting, so that interruptions to insert rivets are reduced to a minimum, and consequently the operation of the riveter becomes almost continuous. The machine is operated by a foot-actuated valve, thus leaving the workman's hands free to handle the work. Examples of aluminium sheet riveting are shown in Fig. 5. At A is shown a riveted seam in No. 16 gauge sheet, ⅝in. pitch; and at B 1½in. pitch, ¼in. diameter, cup-head rivets being used.

### THREADING ALUMINIUM JOINTS.

In almost every case in which bars or sections of aluminium have to be fastened together by screws and bolts it is essential that aluminium screws and bolts should be used for the purpose, any risk of corrosion thus being eliminated. Screw threads can be chased satisfactorily in a lathe using a single-pointed threading tool with considerable top and side rake. Hand and machine taps will produce accurate threads if they are of the spiral flute-ground thread type. Slightly oversize taps materially assist in maintaining the required dimensions of holes in aluminium and

its alloys. That is, aluminium, on account of its lower modulus of elasticity, has more recoverance after a tapping operation than steel, and this is best compensated for by the use of slightly oversize taps. Thorough lubrication during the process is necessary to produce the best results. Paraffin or a mixture of paraffin and pure lard oil in equal parts invariably give very satisfactory results.

In assembling screwed joints which may need in time to be taken apart, measures should be taken to lessen or avoid seizing of the threaded surfaces. In

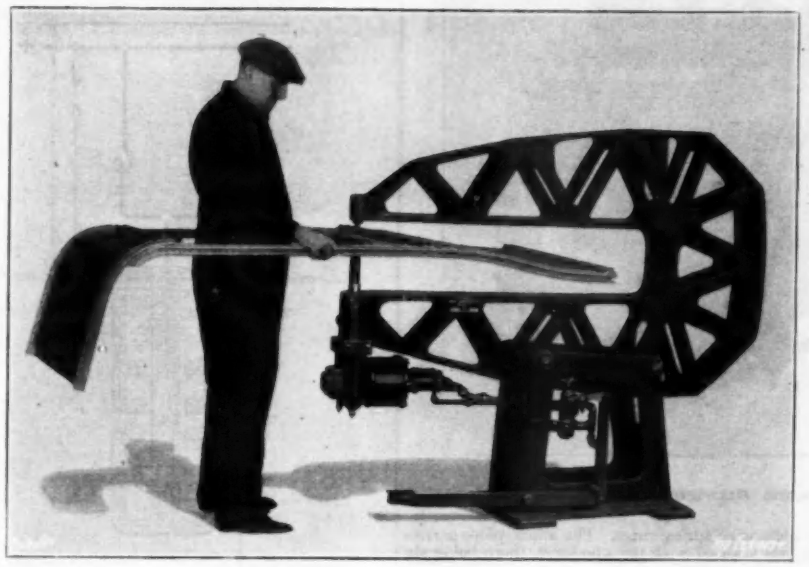


FIG. 4—ALUMINIUM RIVETING MACHINE

cases in which a certain amount of play is not objectionable a fairly loose fit between the threaded areas is usually sufficient. But for tighter fits when considerable pressure occurs, the friction surfaces should be coated with an "anti-seize" compound in the form of a paste. When the threaded joint is to be periodically taken apart this paste may be readily employed at each re-assembly. A more permanent protection is afforded, however, by a coating of zinc by electro-deposition on one of the threaded surfaces. This treatment minimises or entirely eliminates seizing; it has also the added advantage that each separation and rejoining of the threaded parts involves no renewal of the coating.

### FLANGING AND SEAMING ALUMINIUM.

The various methods of jointing aluminium already described do not include one of the most important mechanical methods of jointing aluminium sheet material. Many joints in sheet aluminium fabrication are made in various forms that do not require soldering, welding, or riveting. The parts to be joined have

FIG. 5—SHEET RIVETING OF ALUMINIUM

the sheet edges formed at different angles to suit the type of joint decided upon; the sheet edges are then formed or folded over each other, and finally closed between rolls or by hammering.

Where the output of aluminium sheet products is considerable use is extensively made of ingenious automatic flanging and double seaming machines that will produce a perfect double-seamed joint on cylindrical, elliptical, square, or irregular work very quickly. Jointing by this process is almost universally confined to thin-gauge aluminium from $^1/_{64}$in. to $^1/_{16}$in. in thickness. Owing to its malleability and ductility aluminium lends itself most satisfactorily to the various processes in jointing by flanging and seaming. The difficulty encountered in the formation of various joints, owing to the refractory oxide, naturally has no effect upon this mechanical process. Not only is the flanging and seaming of aluminium joints an economical method, but the joint is also remarkably strong and easily made. Water-tight joints can be secured by double seaming methods when care is taken to obtain true working edges before finally closing the seams. Intricate aluminium articles are sometimes spun in sections in the spinning lathe; usually these parts are joined together by flanging, seaming, riveting, welding, or hard soldering.

In the foregoing article no attempt has been made to enumerate all the methods by which aluminium is capable of being jointed, but those selected illustrate the fact that during recent years considerable attention has been given to the devising of new methods, and more especially of jointing by electrical and gaseous methods and by various mechanical joints.

## Power Stations and Air Pollution.

THE following notes on "Power Stations and Air Pollution" are taken from Dr. Pearce's inaugural address to the Junior Institution of Engineers on December 4th.

During the past two years, said the author, public attention in this country has been very much focussed on the question of air pollution arising from the construction and operation of super-power stations. This has been largely brought about by the modern practice of concentrating more and more power in single generating stations. It is true to say that effective measures are available to-day for dealing with smoke and ash dust emissions from chimney stacks. This is especially the case with stoker-fired boilers, but in view of the fineness of the dust content of the ash when pulverised fuel is adopted, the problem is then not so simple. The controversy which raged round the erection of the new Battersea Power Station, however, had reference to the much more difficult problem of arresting the possible damage to building and vegetation, and the alleged danger to life, due to the sulphur oxides contained in the products of combustion issuing from the chimneys.

The controversy referred to unfortunately tended to attribute to electrical generating stations and power producers in general the responsibility for the present state of the atmosphere, and to regard a solution of this problem as their peculiar liability. It is surely most important to keep a right perspective of the whole matter.

No attempt can be made to deny the possibility of increased pollution of the atmosphere in a circumscribed area by grit and dust and sulphur acids—unless steps be taken to prevent their emission—as the result of concentrating more and more power in single generating stations. But that is not to say that the innumerable industrial power plants and the millions of domestic chimneys do not contribute their quota, and in fact by far the major proportion, to the existing pollution.

I have said that effective measures are available to-day for eliminating smoke and the ash and dust content of flue gases. Cyclone plants, spray and film washers and electro filters all find a place in modern power stations. In conjunction with each of these it is nevertheless necessary to erect chimneys of not less than 300ft. in height. Where pulverised fuel plants are used the electro-filter is generally conceded to afford the best solution, as by this means it is possible to secure an elimination of 95 per cent. or more of the dust. Unfortunately, it is a costly expedient, amounting to some 12s. per kW of plant installed, or, say, 4 to 5 per cent. of the total plant outlay. For this reason cyclone plants, with or without the addition of washers, are sometimes preferred. There can be little doubt that the dust problem, which is more specifically related to the use of pulverised fuel, has retarded the greater use of the last-named system of firing boilers. Electrical power producers stand for clean air, and designers of modern generating stations are anxious to adopt the best means available for rendering innocuous the flue gases emitted from the chimneys. During the last three years, by the collaboration of engineers and chemists, much research work has been carried out by the London Power Company, experimental plants have been erected, and the results secured have conclusively shown that the emission of sulphur fumes can be reduced to a negligible quantity. As bearing on this question, it should be pointed out that coals vary greatly both in their ash and sulphur contents. The selection of a coal with a low ash and low sulphur content—if obtainable—is obviously to be preferred from every standpoint so long as the choice reasonably satisfies the condition of obtaining the maximum output of steam at the lowest cost. The sulphur that coals contain may exist, broadly, in three forms:—(*a*) As pyritic sulphur, (*b*) as sulphate sulphur, (*c*) as organic sulphur. The pyritic and sulphate sulphurs can be very considerably reduced by mechanical pre-treatment processes at the colliery, such as washing or dry cleaning. By one or other of these processes it is possible to remove or exclude a certain amount of sulphur-bearing material in the coal, and by the extent to which this is an economical proposition, the difficulties and expenditure inherent to the subsequent treatment and removal of the sulphur oxides from the flue gases by means of special plant at the stations are thereby reduced. It may be that in the years to come none of the large power stations will use untreated coals, but may find it more economical to use fuels from which objectionable materials have been removed at the collieries before transit to stations. The detailed accounts of the earlier research work on the elimination of sulphur oxides from flue gases which have been undertaken by the London Power Company during the past three years were published in a paper presented to the World Power Conference in June, 1930, by the speaker.

Since that date and following the general line of development therein described further investigations have taken place on the same experimental plant with a view to the more accurate determination of water quantities, the amount of catalytic material surface to be provided for a given volume of gas and the best form and disposition of this surface in the gas stream. In addition, one large-scale plant has been built at the company's Grove-road Station, and is in operation in conjunction with a boiler having a normal evaporation of some 70,000 lb. of water per hour. The introduction of catalytic surfaces in the path of the gases was early on shown to be very beneficial by way of increasing both the elimination of sulphur from the gases and the conversion of $SO_2$ to $SO_3$.

It has also been demonstrated that a higher elimination of sulphur from the gases can be obtained when the $CO_2$ content of the gas prior to entering the treatment chambers is reduced to 9 per cent. or below, or, in other words, when the oxygen content of the gas is increased to 10 to 11 per cent. The same effect was obtained by ensuring that the wash water or other liquid used in the process was aerated. The general result has been to obtain not only a higher elimination of sulphur, but a greater conversion of sulphite to sulphate in the final effluent.

It has been found possible to reduce the sulphur content of the exit gases to between 0·02 and 0·04 grains of sulphur per cubic foot. Various alkaline wash waters, such as soda ash, suspensions of lime or chalk, ammoniacal liquors, have been considered and/or experimented with, and alternative methods of application have been tried, with a view to the final elimination from the gases of any residual sulphur after allowing as great an area as possible for plain water washing.

It is now possible to say that with the fuels used "sulphur" eliminations of the order of 97 to 98 per cent. have been continuously obtained from the gases, whilst the resultant process effluent can be discharged into the river Thames in such a condition as to meet the stringent requirements laid down by the Port of London Authority. Not the least difficult portion of the task has been the mechanical design of the plant required to meet the foregoing chemical and other reactions. Plants embodying the above principles are in course of construction at the Battersea, Deptford and Willesden stations of the London Power Company.

The foregoing work has attracted considerable attention in the United States, and latterly reports have been issued dealing with experiments conducted by the University of Illinois on the general subject of flue gases. The primary object of these investigations was to determine how best the solubility of $SO_2$ in water could be brought about so as to reduce the amount of water or other washing medium to a minimum. The results emphasise the conclusions previously established by the London Power Company—on large-scale plants as distinct from laboratory experiments—of the value of utilising catalysts in the cycle of the process, both in securing a very high degree of elimination of the sulphur oxides and of reducing the volume of water in circulation.

Another gratifying feature of the later developments has been the gradual reduction in the cost of treating the gases, and it is now well within the economic limit, quite apart from the possibility of obtaining a by-product in a marketable form. As a matter of interest, the total operating cost of the Grove-road plant for pumping power and cost of lime alkali at present represents 3d. per ton of coal burnt.

More recently the London Power Company has experimented with another system in which the gases are treated with a ferric sulphate solution in substantial absence of metallic iron; the acidity of this solution is controlled by the addition of calcium carbonate, which also removes the sulphate iron from the solution. With this system little or no water should be required except as make-up, and it may therefore prove to be economical in application for stations situated inland on non-riverside sites. The location of power stations within the limits of a city has generally been avoided in the past on the ground, *inter alia*, of possibility of nuisance. If, as it is believed, a complete and economically satisfactory solution has been found for a station located well within a populated area, the above consideration need not arise, and in turn may have a reaction on problems of transmission.

It has been stated that there is no "sulphur" problem in France or Germany, and that in the case of the last named country this is partly attributable to the lowness of the sulphur content of the coal, which averages about 1·5 per cent. I think this is rather an unsatisfactory explanation, in view of the very low percentages of sulphur in many of the coals from English and particularly Scottish coalfields. As indicated above, the inclination is rather to take a one-sided view of this question, and it may be that in Germany, at any rate, the authorities refrain from pushing matters to such a point as to constitute a definite hardship on industry, that a more tolerant view is taken of the place of power production in the modern world, and that industry is not forced to take ameliorating steps which would go far beyond the bounds of economy.

## Oerlikon Mercury Arc Rectifiers.

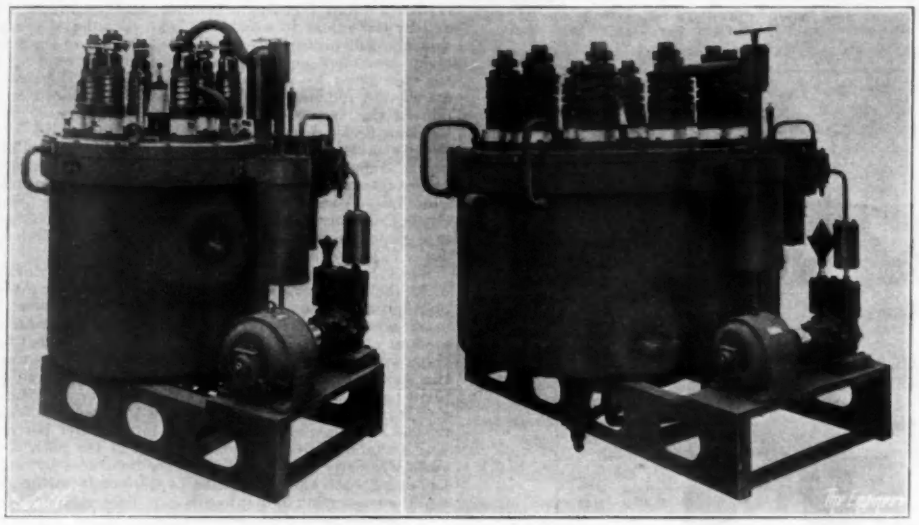
ALTHOUGH the principle of all mercury arc rectifiers used for converting A.C. into D.C. is the same, there are naturally differences in construction. Just as makers of other plant have their own ideas about constructional details, so have builders of rectifiers, and no apology is needed for describing the rectifier made by the Oerlikon Company, of Oerlikon, Switzerland. The special advantages claimed for it are small dimensions, absence of backfiring, and heavy overload capacity. The standard six-anode type shown in Fig. 1 can be used for D.C. pressures up to 15,000 volts and can give 1000 kW continuously at 3000–4000 volts for D.C. railway operation. A pump unit serves to maintain the vacuum and a measuring equipment is provided for checking the vacuum and for controlling the pump. Details of the complete outfit are shown in Fig. 3, where the figures 1–31 refer to the following parts :—1, container ; 2, anode plate ; 3, auxiliary anode ; 4, ignition coil ; 5, ignition rod ; 6, water flow control apparatus ; 7, main anode insulator ; 8, mercury packings ; 9, main anode ; 10, anode screen with grid ; 11, water outlet ; 12, rubber tubes ; 13, cathode plate ; 14, cathode insulator ; 15, three-phase motor ; 16, vacuum pump ; 17, vacuum pump vanes ; 18, oil trap ; 19, motor for vacuum cock operation ; 20, no-volt release ; 21, return spring ; 22, electrically operated vacuum cock ; 23, heating resistance ; 24, vacuum augmenter ; 25, mercury vapour jet ; 26, hand-operated cylinder cock ; 27, vacuum measuring tube ; 28, electrical vacuum meter ; 29, series resistance ; 30, transformer ; 31, cathode screen.

The cathode mercury is contained in the cavity formed by the ring-shaped cathode insulator 14 and the cathode plate 13, which is pressed against the rectifier tank by insulated bolts with spring rings. The anode plate carries the anode insulators 7 with the anodes 9, there being six or twelve anodes according to the size of the rectifier. A cylindrical screen 10 surrounds each anode and protects it from direct radiation from the cathode and against rising mercury vapours. This patented arrangement is claimed to prevent backfiring under all conditions and to offer other operating advantages. The insulated funnel-shaped cathode screen 31 is another device which screens the anode from the cathode. In the middle of the cathode plate is the ignition rod 5, which is carried by a spring provided with an iron core energised by the solenoid 4. When the solenoid is energised, the ignition rod is forced down into the cathode and current then flows through the rod, whilst when the solenoid is de-energised the spring draws the rod up again and the current flowing through the ignition rod is interrupted and an arc is thus formed. Three excitation anodes, 3, serve for maintaining the arc even under light load conditions, and they are fed by a small auxiliary transformer.

The cooling water first passes through the anode plate, then through the jacket of the rectifier container and finally through the anode plate. Normally, the anodes are not water cooled, the heat being dissipated for the most part by radiation. Only when the rating of units is very high are the anodes cooled by means of water, which then serves mainly for protecting the seals and insulators. In every case the seals consist of asbestos and mercury, so that the ingress of air into the rectifier is definitely prevented. Moreover, the mercury presents the advantage that any defect in the seal becomes noticeable, each packing being provided with a gauge. Wherever possible, the use of glasses which tend to amalgamate is avoided and the level is indicated by a small float.

As usual, there are two pumps for maintaining the vacuum, a main vacuum pump and a vacuum augmenter. The first creates a vacuum of about $^{3}/_{100}$ mm. of mercury and the second increases this vacuum to about $^{1}/_{1000}$ mm. The main vacuum pump, which is shown at 16, is a rotating vane pump, which runs in oil and is driven directly by a small slow-speed squirrel-cage motor. The vacuum augmenter 24 is a static mercury vapour pump designed on well-known lines. The mercury is brought to boiling point in a cylindrical container by means of a heating device under it, and the upper part of the container carries the suction pipe. The rising mercury vapours are led upwards through a jet 25 and then through a nozzle directed downwards, where the mercury vapours condense on the cooled walls of the cylinder and the air drawn in is driven downwards and taken away by the vacuum pump through the suction pipe. Between the vacuum pump and augmenter there is an electrically operated cock, which opens when the vacuum pump is running and closes automatically when the pump is shut down. The cock is opened by a small squirrel-cage motor. During the process a closing spring is put under tension and the spring is released by a no-volt coil in parallel with the motor 15, when the latter is shut down, thus causing the cock to close. The hand-operated cock 26 on the cylinder serves for shutting off the cylinder from the pump set.

The vacuum measuring device evolved by the Oerlikon Company is simple and reliable. The discharge tube 27 is connected through a regulating resistance 29, and the milli-voltmeter to the potential transformer 30, and the



FIGS. 1 AND 2—SIX AND TWELVE ANODE RECTIFIERS

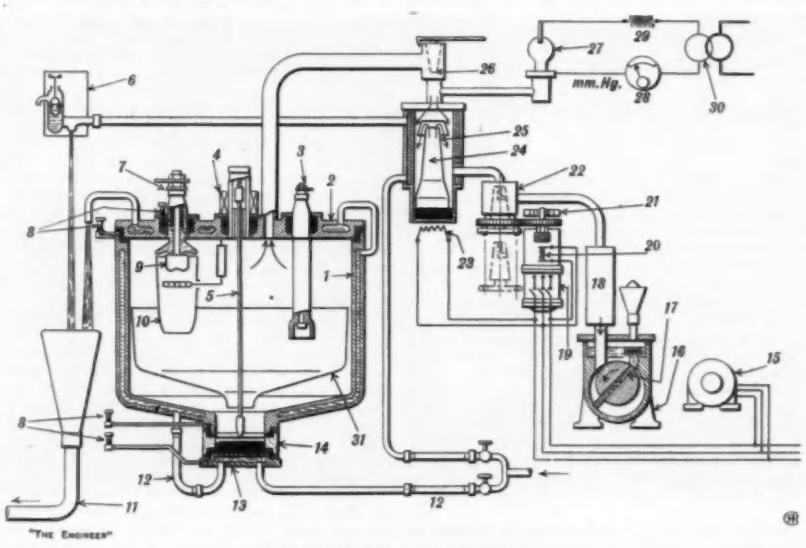
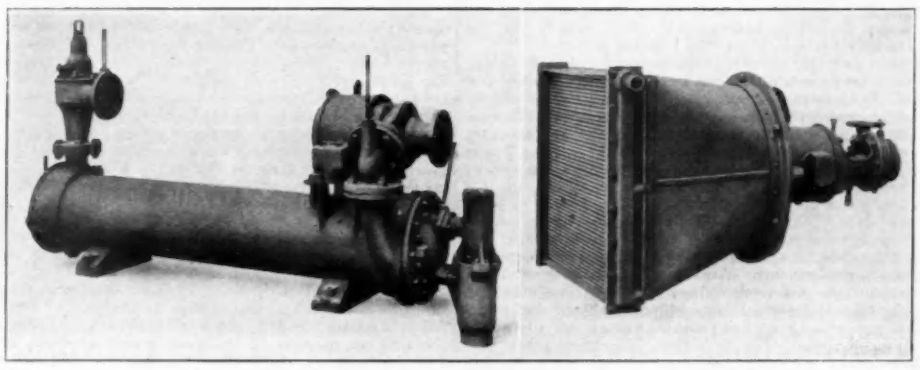



FIG. 3—DETAILS OF RECTIFIER



FIGS. 4 AND 5—WATER AND AIR COOLERS

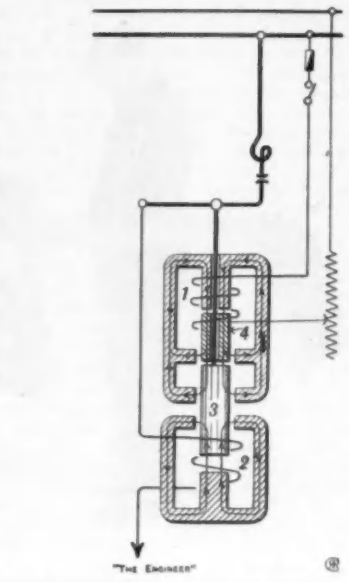



FIG. 6—DETAILS OF CIRCUIT BREAKER

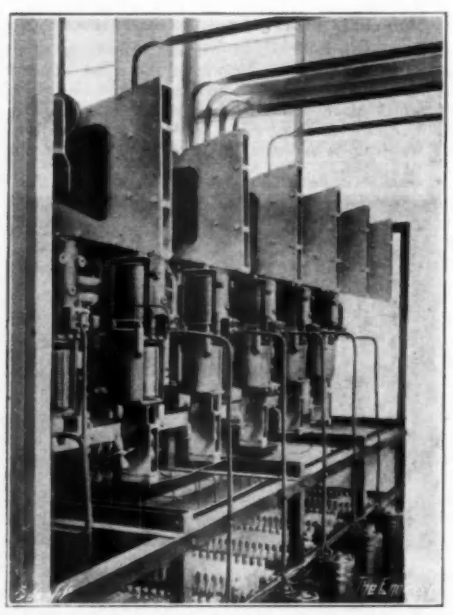


FIG. 7—FEEDER CIRCUIT BREAKERS

discharge current flowing through the tube serves for measuring the variation in vacuum. In so far as they endanger operation, the arrangement indicates the presence of foreign gases and vapours, and it is possible to arrange for the automatic control of the vacuum, according to the degree of vacuum. As shown in Fig. 1, the rectifier cylinder and pump unit are mounted on a common bed-plate, so that the apparatus does not have to be dismantled when it leaves the works, the rectifier being insulated with a layer of bakelised paper giving good insulation coupled with mechanical strength. As we have said, the rectifier shown in Fig. 1 is a standard rectifier with six anodes, whilst that shown in Fig. 2 has twelve anodes. Both rectifiers are completely erected in the works, and can be put into service immediately they are placed on the site. If desired, the rectifiers can be fitted

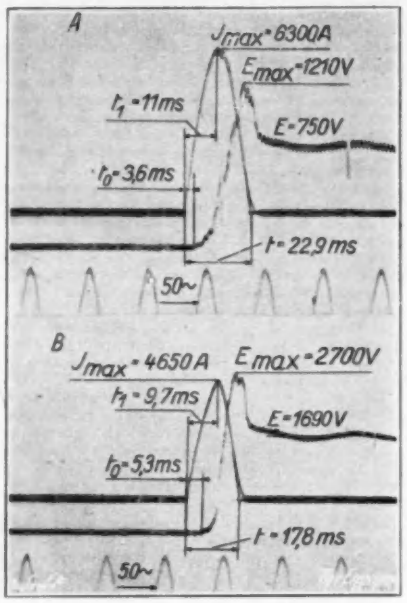



FIG. 8—CIRCUIT BREAKER OSCILLOGRAMS

with rollers to enable them to be moved from place to place with ease. With the transformers zigzag connected on the secondary side and a constant primary pressure, there is a pressure drop of about 5 per cent. from light load to full load. With the six-phase zigzag connection, the drop can be reduced to below 4 per cent. To enable the D.C. pressure to be adjusted to meet different operating conditions, the transformers are provided with tappings which can be changed when the plant is out of use, whilst, if the pressure must be varied whilst the plant is at work, an induction regulator is provided on the primary side of the transformer or alternatively the transformer may be provided with on-load tap-changing gear.

When there is a supply of water free from chalk and sludge, the rectifier may be cooled directly by means of that water, but if the water is unsuitable for the purpose

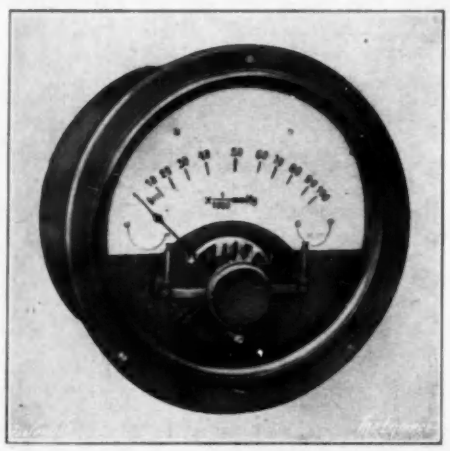


FIG. 9—VACUUM GAUGE

an intermediate cooler may be provided. The rectifier is then cooled by fresh water circulating in a closed circuit, and cooled in the intermediate cooler, which can easily be cleaned. An intermediate cooler with the circulating pump combined is shown in Fig. 4. In the case of rectifiers which have to work at variable load, the quantity of water is adjusted automatically in accordance with the load by means of governing gear controlled by the rectifier temperature. Where water is scarce or where the rectifier has to be independent of a water supply, a cooler in which the water is maintained at the correct temperature by means of air, is supplied, as shown in Fig. 5, the cooler being provided with a motor-driven helical fan and circulating pump. The helical fan is claimed to reduce the power consumption and to ensure smooth running, whilst the cooler itself is said to occupy little space. If no fresh water is available for cooling the vacuum augmenter, that part of the apparatus must be cooled by means of a closed circuit system, but as the combination of this cooler with that of the rectifier prevents difficulties, arrangements are made for cooling the vacuum augumenter independently by means of a thermo-syphon cooler mounted close to the rectifier. For small outputs—*i.e.*, for currents up to 250 or 300 ampères—the Oerlikon Company has devised a special self-cooling rectifier, which is said to have proved highly suitable for small automatic railway installations.

As protection against shorts on the D.C. side is a matter of importance, special attention has been paid to the design of the circuit breakers, which open the circuit rapidly and without entailing the release of the breaker on the A.C. side. Referring to Fig. 6, the breaker has a permanently excited, switching-in, and holding coil 1,

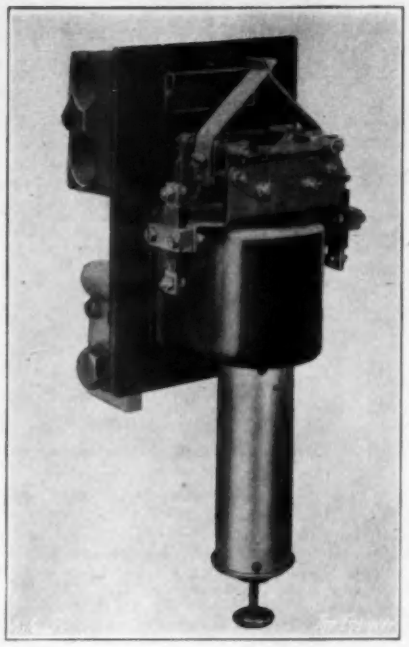


FIG. 10—RE-CLOSING RELAY FOR D.C. BREAKER

and a switching-off coil 2 energised by the main current. The core shown at 3 is linked up to the contact gear, and is subjected to the action of both coils. An auxiliary core 4 can move freely between the core 3, and the holding magnet 1. Owing to the shape of the magnet casting, the main core 3 separates from the auxiliary core 4 at the moment the current assumes an excessive value, in which case the lines of force of the holding magnet can close directly without having to pass through the main core, and as a result the force exerted by the holding magnet on the main core and consequently on the lever of the

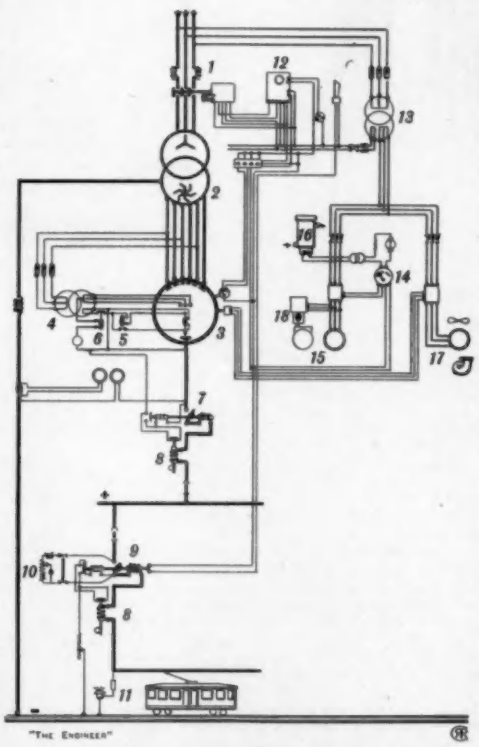



FIG. 11—AUTOMATIC RECTIFIER CONNECTIONS

circuit breaker entirely vanishes and causes a rapid interruption of the circuit. Re-switching occurs as a result of the holding current being cut off and switched on again. This causes the auxiliary core 4 to fall away from the holding magnet and to join up again with the main core and at the same time, owing to the action of the flux which also passes partly through the main core, the auxiliary core carries with it the main core, when the holding current is switched on again, with the result that the circuit breaker is closed. If, however, the overload still persists, the two cores separate and the main circuit is again opened. By suitably dimensioning the cores, it is possible to make the value of the current for which the release takes place at the moment of switching in considerably lower than under normal service conditions. This results in a more rapid opening of the circuit breaker than would normally be the case when closing the breaker on an overload, and in consequence in certain cases a line can be switched on again directly after the release without danger and without testing the line for short circuits.

Incidentally, in the case of automatic installations, this permits of the employment of a very simple arrangement for the control of the automatic circuit breakers associated with the outgoing lines. Moreover, owing to the fact that the holding and switching-in coil is connected to the D.C. supply, it also acts as a no-voltage release. The setting of the automatic circuit breaker is adjusted by varying the holding current by means of a resistance with a sliding contact calibrated for the pressure in question. Five of

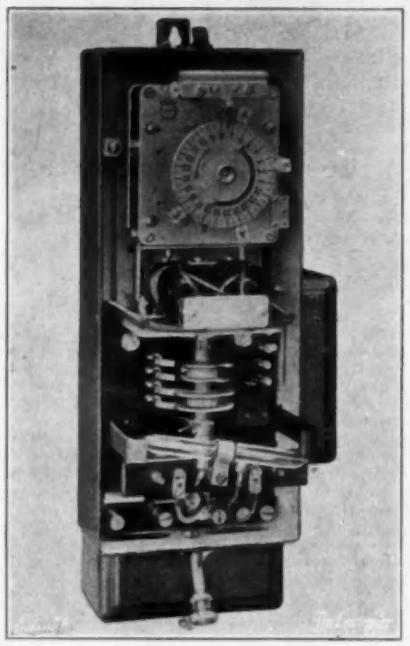


FIG. 12—RE-CLOSING RELAY

these circuit breakers controlling the feeder circuits of fully automatic mercury rectifier installations are shown in Fig. 7. These circuit breakers can be built for all current and pressure conditions encountered and the oscillograms A and B, Fig. 8, which were taken during the interruption of short-circuit currents at a pressure of 750 and 1690 volts respectively, give information as regards the rupturing speed obtainable. Owing to the provision of a powerful blow-out and to the adoption of a high contact pressure, the wear of contacts is small and reliable operation of the breaker is ensured with little attention. During tests carried out with a trial circuit breaker it easily withstood 1000 dead short circuits, and the wear with a current of 6000 to 7000 ampères at 750 volts in each case was 1 mm.

One of the most important parts of these mercury vapour

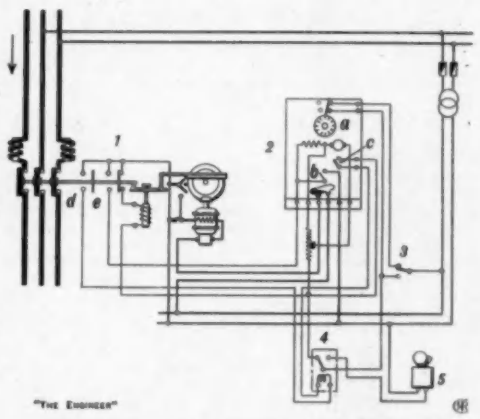



FIG. 13—RE-CLOSING RELAY CONNECTIONS

equipments is the vacuum gauge, shown in Fig. 9, which is used as a contact device for the control of the vacuum pump and the alarm signal. It is provided with a drop fork contact which is said to have proved very satisfactory. The pointer of the instrument, together with the contact device, is pressed against fixed contact segments by a small motor, and released again periodically. Good contact is said to be ensured, and the switchgear can be controlled without intermediate relays. In the case of automatic sub-stations, the relays which serve for the control of the automatic circuit breakers play an important part in the operation of the plant and the type of relay used for effecting the re-closing of D.C. breakers after release is shown in Fig. 10. It is wound as a maximum current relay and has opening contacts and a locking device. The relay is connected in series with the D.C. breaker to be controlled, and opens its contacts with a current somewhat lower than that for which the release of the circuit breaker takes place. In the case of an overload, by means of an auxiliary contact, the circuit breaker itself interrupts the circuit of the combined switching in and holding coil, and re-switching only takes place when these auxiliary

contacts are bridged over by the contacts of the relay shown in Fig. 10, and these contacts operate with a time lag.

The diagram, Fig. 11, shows two circuit breakers 7 and 9 arranged in this way. In the case of the line circuit breaker 9 the switching is made dependent upon the absence of short circuits in the line in question, and in the case of the rectifier circuit breaker 7 upon the excitation of the mercury rectifier. The illustration, Fig. 12, shows a relay which, after the release of the circuit breaker, causes it to close again for a limited number of times within a given period, and then causes it to be locked in the open position,

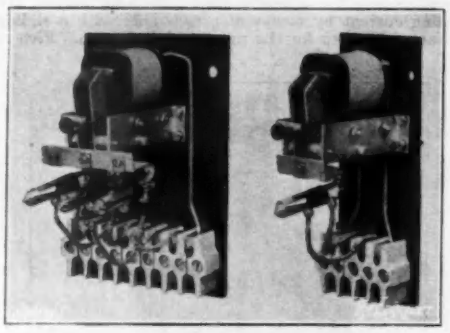


FIG. 14—AUXILIARY RELAYS

if these switching operations are followed immediately by the release of the gear. The relay can be used for the control of A.C. as well as D.C. circuit breakers, and in the latter case the re-switching gear can be designed with or without an automatic short-circuiting testing device. The arrangement for an oil circuit breaker with motor remote control where the re-switching relay is combined with a time switch which causes the switching-in and switching-off of the circuit breaker in question at the desired times of the day is shown in Fig. 13, where 1 is the oil circuit breaker with remote control, 2 the control equipment, 3 a single-pole change-over switch, 4 a shutter type relay, and 5 a signalling device.

The relay consists of a vertical spindle driven by a small electric motor which tilts a pivoted mercury contact tube by means of an arm, with the result that the mercury in the tube runs over a contact and gives a connection of short duration, which gives rise to the necessary current impulse for the switching-in of the circuit breaker. If the circuit breaker trips, the contacts *b*, which are open in the zero position of the relay, are bridged over by the auxiliary contact *c* of the oil circuit breaker, and as a result the motor of the relay is connected to the supply and starts to drive the spindle carrying the arm. Before the mercury contact tube operates for the first time the contacts *b* close, with the result that the motor is forced to continue to run, even when the circuit breaker is closed and its contact *c* is open.

Once, owing to the impact of the lever, the mercury contact tube has caused the number of impulses provided for and the corresponding switching-in operations have been completed, the relay continues to work when the circuit breaker remains closed until it reaches the zero position, when the contacts *b* open again, and the driving motor is brought to a standstill. But if the oil circuit breaker trips after the last switching-in impulse, the locking contact *c* comes into play, and causes the operation of a shutter type relay by way of the contact of the oil circuit breaker and interrupts the current supply of the motor of the relay, giving a signal at the same time. The relay and circuit breaker are thus locked. Once the fault has been cleared, the re-switching is done by resetting the shutter type relay in the working position. By means of a contact *a*, clockwork mechanism switches the current supply for the relay and no-volt coil for the circuit breaker on and off, and thus closes and opens it at the desired times, the arrangement being used, for example, in fully automatic mercury rectifier installations with remote control. The type of auxiliary relay used for ignition and for the supervision of the excitation, for signalling purposes, and for the control of apparatus, &c., is shown in Fig. 14. In this apparatus, it may be explained, contact is made by a mercury tube which has a fairly large rupturing capacity. The relays can be built with any number of poles and are characterised by the small amount of power required to operate them, and by the absence of noise when the coil is fed with A.C. The value of the current for bringing the relay into play can be adjusted by a small set screw.

Another part of the equipment worthy of note is

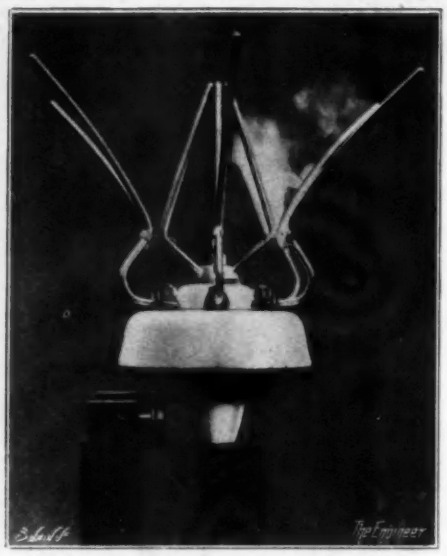


FIG. 17—SURGE PROTECTIVE GEAR

the Oerlikon patented surge protective gear—Fig. 17—which, owing to its large current capacity, and fine pressure adjustment, is said to afford very effective protection against surges on the D.C. side.

The diagram of connections, Fig. 11, relates to a fully automatic electric railway installation, and the figures 1–18 refer to the following parts :—1 is the oil circuit breaker; 2, main transformer; 3, rectifier; 4, excitation transformer; 5, the ignition relay; 6, excitation relay; 7, quick-acting circuit breaker; 8, re-switching relay; 9, quick-acting circuit breaker; 10, short-circuit testing resistance; 11, surge protective gear; 12, operating gear for the oil circuit breaker; 13, auxiliary transformer; 14, contact vacuum meter; 15, vacuum pump; 16, vacuum augmenter; 17, cooling set, and 18, the automatic vacuum cock. The time switch with re-switching devices closes the oil circuit breaker at the desired moment, with the result that the rectifier and the ignition and excitation device are put under pressure. The separate ignition winding in the excitation transformer sends a current through the ignition coil of the rectifier and draws the ignition rod towards the cathode, and when contact has been made a current flows through the ignition rod and the cathode and, at the same time, excites the ignition relay, which interrupts the ignition coil, with the result that the ignition rod returns to the position of rest and a spark occurs between the cathode and the ignition rod. This process recurs until the three-phase excitation sets in, when the excitation current interrupts the ignition by means of the excitation relay.

Part of the excitation current flows through the switching in and holding coil of the circuit breaker, which is thus made to close. The line circuit breaker closes when the line pressure applied through the short circuit testing resistance reaches a value sufficient to enable the switching-coil connected to the line to perform the operation, the short-circuit testing resistance being dimensioned so that it can remain continuously in circuit without danger, even in the case of a short circuit. In order that it may be possible entirely to isolate the line from the bus-bars in the event of a permanent short circuit, a circuit breaker with a release dependent on the temperature of the resistance is connected in series with it. As permanent short circuits to earth are infrequent, in most cases it is sufficient to provide a fuse on the short circuit-testing resistance.

The auxiliaries are fed separately by a small transformer and their operation is independent of the switching on and off of the rectifier. The vacuum plant is controlled by the contact device of the vacuum gauge, whilst the cooling set is switched on and off by means of a thermo-contact fitted on the rectifier. The protective devices on the three-phase side consist of maximum current and no-volt release, with automatic re-switching arrangements, a D.C. maximum current and no-volt release, with automatic short circuit testing and re-switching features, a device to protect the rectifier against excessive temperature, a device to protect the rectifier in the event of insufficient vacuum, and a signalling device which comes into play in the event of disturbances in the vacuum plant. Any fault that may occur is immediately indicated on a panel by means of drop shutters. The control of the plant can be made to be dependent upon remote control as well as on a time switch. It can also be made to depend upon the value of the current, or the pressure of the sets working in parallel, or of the overhead line, in which case another control relay is inserted in the auxiliary circuit.

With a view to saving space, the whole of the auxiliary gear for ignition and excitation and the control apparatus for the cooling set and vacuum plant and vacuum measuring device, are mounted in a cubicle insulated from earth, as shown in Fig. 15, the cubicle being placed next to the rectifier. Owing to the fact that all the gear mentioned is designed for automatic operation under normal conditions, it is unnecessary to handle the switches on the cubicle, which, like the rectifier, is arranged so that contact cannot be made with the gear whilst the plant is alive. As all the auxiliary gear controlling the various circuits is directly or indirectly connected to the rectifier casing, and is thus subjected to the D.C. pressure, the practice of insulating the plant from earth presents the advantage that the gear can serve for all D.C. pressures, without impairing safety. In order to make it possible to operate the switches mounted on the cubicle in the case of emergency, an insulated box spanner is provided. Another noteworthy feature of the equipment is that the auxiliary motors are protected by means of triple-pole automatic circuit breakers, with a thermal maximum current release and, in consequence, the danger of the motors burning out in consequence of running on one phase, as may happen when fuses are employed, is avoided. The illustration, Fig. 15, shows an 800 kW, 1550-volt installation, built for the Bernese Oberland Railway Zweiluetschinen, and Fig. 16 a 500 kW equipment at Worb.

The London representative of the makers is Mr. G. Wüthrich, Oerlikon, Ltd., Victoria House, Southampton-row, W.C. 1.

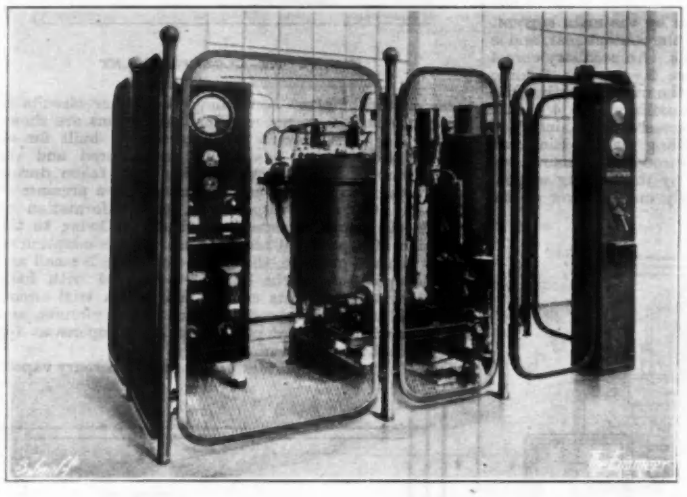


FIG. 15—800-kW TRACTION RECTIFIER EQUIPMENT

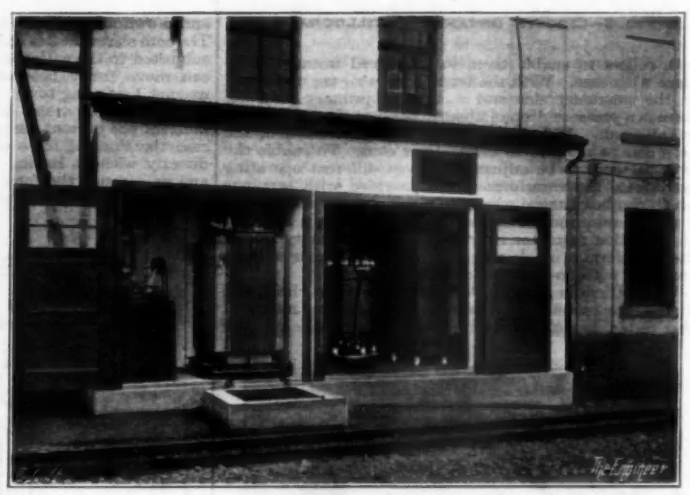


FIG. 16—500-kW RECTIFIER EQUIPMENT AT WORK

## OBITUARY.

### MR. HERBERT JEWSON.

NEARLY thirty-five years ago Mr. Herbert Jewson, who died rather suddenly on November 30th, joined the firm of Hobbies, Ltd., Dereham, and immediately set to work evolving new tools, and, what is more, machinery and plant with which to turn them out. Among his many inventions one which may be particularly mentioned is the ingenious machinery for the manufacture of fretsaws, which is now able to turn out over ten million saws a year. He was appointed a director a number of years ago, and had continued in control of the engineering department until less than two years ago, when ill-health unfortunately forced him to give up active interest. Nothing was too much trouble for Mr. Jewson to undertake in promoting the advancement of the firm, and he had travelled in most parts of the world. He went to the United States, and in 1921 journeyed to Italy to gain first-hand information of a new class of fretwork called Autofret. A few years later he undertook a business tour of Egypt, Australia, New Zealand and South Africa. Apart from his business activities he took much interest in public affairs, and had represented Dereham on the local Council, being chairman in 1922.

THE Royal Commission, presided over by Mr. Justice Duff, and of which Lord Ashfield is a member, the investigations of which may lead to the amalgamation of the Canadian Pacific and the Canadian National railways held its first meeting in Ottawa on December 4th.

## Railway and Road Matters.

IT is expected that the first 1000ft. berth shed on the Southern Railway Company's dock extensions at Southampton will be completed in June next.

SUPPLEMENTING the paragraph herein on November 20th as to 198,000 steel sleepers—equivalent to 94 miles of track—being laid on the Great Western by the end of the year, it is to be recorded that a further 50 miles, requiring 105,000 steel sleepers, are to be taken in hand next year.

THE plans for the widening between Southampton West Station and Millbrook Station, mentioned herein on December 4th, show that the inconvenient road level crossing at the east end of the station is to be replaced by an overbridge near the west end. The widening will be on the water side of the railway; there will be four platform lines and a bay at the west end.

THE Newhaven-Dieppe steamer "Versailles," which was disabled about an hour after leaving the former port on December 3rd, was a contribution of the French State Railways in 1921 towards their share in the jointly owned fleet. She is French-built, and has a gross tonnage of 1903, and a net tonnage of 535, and is one of the three fastest boats—25 knots—in this service; the two others are the "Paris" and the "Worthing," both Denny-built.

AT Borough Market Junction, on the west side of London Bridge Station on the Southern Railway, two lines, going towards Charing Cross, leave the four lines between London Bridge and Cannon-street. Over 1200 trains pass over this junction daily and its maintenance gives the engineering department considerable concern. It has now been decided to relay the whole junction—crossings, switches and rails—in manganese steel, constructed by the Titan Trackwork Company, of Sheffield.

THE four lines of way on the Chelmsford line of the London and North-Eastern used to end at Romford Junction, 12 miles from Liverpool-street. Since then, the two lines forward to Gidea Park have been made into four, and a contract has now been let for carrying on the four lines thence, through Harold Wood and Brentwood—including Brentwood "bank"—to Shenfield, where is the junction for the Southend branch. The new down slow line will have a burrowing junction connection with the Southend down line.

IT was stated recently by Mr. Pybus, the Minister of Transport, that the London and North-Eastern Company had informed his Department that it was actively considering the question of developments at Liverpool-street Station, and in the former Great Eastern Railway area, and that, in the event of the London Passenger Transport Bill becoming law, it was anticipated that a scheme would be ready for submission to the Standing Joint Committee of the proposed Transport Board and the amalgamated railway companies, which would be set up under the Bill to consider proposals affecting their joint interests.

THE greater expedition with which wagons are shunted and marshalled into fresh trains at the Whitemoor hump yard has caused embarrassment to the London and North-Eastern Railway, as the accommodation on the lines south of Whitemoor is not sufficient to deal with the trains after they have been made up and are ready to depart. To meet the situation new running loops—as indicated in our annual article "Railways in 1930" on January 16th last—are being laid in, and many refuge sidings are being converted into running loops. The latter work allows trains to run direct into the refuge instead of being backed in. There will be fifty such loops, each from 700 to 750 yards long.

WE would like to supplement the notice in our "Seven-Day Journal" of December 4th, to the promotion of Mr. E. J. H. Lemon to be a vice-president of the London, Midland and Scottish Railway to succeed Mr. J. H. Follows, and the appointment of Mr. W. H. Stanier, of the Great Western Railway, as chief mechanical engineer in place of Mr. Lemon, by a brief notice of the career of Mr. Follows. He is the son of an engine-driver on the Midland Railway and joined that system in a minor position in the operating department in 1890. In five years' time he became a station-master and afterwards an inspector, and in 1901 went to the headquarters at Derby. In 1914 he was appointed superintendent of operations and general superintendent in 1919. On the formation, as from January, 1927, of the executive committee for the L.M.S. Railway, Mr. Follows was made one of the four vice-presidents.

IT was fifty years ago on December 10th since an extraordinary and disastrous series of collisions occurred in Canonbury Tunnel, near Canonbury Station on the North London Railway. The tunnel in question is on a curve over which the trains of the then Great Western Railway from Potters Bar ran from Finsbury Park in order to reach the North London Railway and proceed to Broad-street. The signal-box at the Great Northern end was Finsbury Park No. 1, and the other was Canonbury Junction. The block telegraph code between the two boxes provided that, when absolute block was in operation, six beats on the bell signified that the line was obstructed; seven beats gave the same intimation when permissive block was being used. On the morning in question, when No. 1 signalman offered a passenger train, the man at Canonbury refused it by six beats because the section ahead of his box was obstructed by an engine having failed. No. 1 man claimed, however, that he had seven beats, and as that was a signal he was not accustomed to, he went to the block code card and read something about seven beats and permissive working. He therefore let the train go, not only so, but sent three other passenger trains, all of which had been refused by six beats. The result was that each of the following trains came into collision with its predecessor, and four passengers and one of the guards were killed. The man in No. 1 box aggravated his offence by failing to warn each driver that he was being sent forward under permissive working, and, additionally, he put his starting signal to "clear" instead of waiting until the train had been pulled up at it.

## Notes and Memoranda.

THE output of gold from the mines of the Transvaal during October amounted to the record weight of 945,113 oz.

TWO turbo-generators, each of 160,000-kW capacity, running at 1800 revolutions per minute, are being constructed for the Brooklyn Edison Company by the General Electric Company of America.

IT is suggested that the sequoia tree at Palo Alto, in California, is one of the oldest in existence. Records concerning it date back to the year 1769, and as long ago as 1777 it was 137ft. high with a girth at the ground level of 15ft. It is now 23ft. in circumference.

IN a preliminary analysis of the Traffic Census taken in August last on the first-class roads of Durham County, made by Mr. W. J. Merrett, emphasis is laid on the fact that heavy motors show a considerable increase, whilst omnibuses and light car traffic shows a decrease.

THERE is a note of warning in the *Bulletin* of the Hydro-Electric Power Commission of Ontario as to the use of aluminium paint on transmission poles. It is pointed out that its electrical conductivity may create a hazard. Investigations are being carried out on the subject.

A PAPER on "The Care and Maintenance of the Industrial Steam Locomotive" was recently read before the North-East Coast Institution of Engineers and Shipbuilders by Mr. J. W. Hobson. Among other hints that he gave was one for the protection of fire-box crown stays from corrosion. It was, he said, best done by encasing the stays in piping filled with cement.

IN the course of a paper on "Electric Welding," read recently before the Birmingham Electric Club, Mr. C. A. Hadley said that for testing welds in the field the most useful and adaptable method at present is by means of an ordinary stethoscope. By means of this simple appliance defective welds can be detected by the sound produced when struck by a hammer, and an experienced supervisor can readily detect a bad weld, which can be then cut out by a cutting blow-pipe and re-welded.

THE bridge over the Danube joining Belgrade directly with the Banat, at Panchevo, has just been completed. It is 1260 m. long and it is claimed to be the longest in the Balkan Peninsula and one of the longest in Europe. About 20,000 tons of steel, 2500 tons of iron, and 100,000 cubic metres of concrete—for the pylons—were used. The width of the bridge is 11 m. It will serve for railway and vehicle transport and has been so constructed that if the need arises it can be widened to 20½ m.

IN the most recent publication of the Institute of Fuel there is an intriguing article concerning thermo-couples. In it it is pointed out that a couple made of tungsten and molybdenum will give an admirable measure of the temperature to which it is exposed; but such an instrument is subject to oxidation at such temperatures as 1600 deg. Cent., and were it possible to protect the working parts by some form of ceramic, from atmospheric influences, it would be possible to register with accuracy temperatures of the order of 1750 deg. Cent.

IT is claimed by the American Bureau of Standards that molten platinum gives the best standard of light. A flame of standard type burning fuel at a known rate has been used in the past as a standard, but its brilliance varies with changes in atmospheric conditions, but in the now methods, platinum, pure to 1 part in 30,000, is fused electrically in crucibles of thorium oxide. Comparisons with its light are made when the platinum is melting or freezing. Its temperature then is about 3200 deg. Fah. Light produced under these circumstances is remarkably constant. Reproducibility is of first importance for a standard, and the values of the platinum standard are repeatable to a tenth of 1 per cent. The precise value of the new light standard is 58·84 international foot-candles per square centimetre.

IN the course of a paper, presented before the Public Works, Roads and Transport Congress, on the use of coke breeze as an aggregate in concrete, Mr. B. H. Knight cited a failure, which, he said, was a serious one. A group of eight houses was built with external walls, which consisted of clinker concrete, 6in. thick, cement rendered on the outside. The clinker concrete expanded and cracked the rendering, and in spite of repairs the expansion continued until the houses became structurally unsafe for habitation. At the request of the Ministry of Health, the Building Research Staff investigated the cause of this failure, which had been assumed to be due to the formation of sulphur compound in the cement. The actual cause was shown to be due to the presence of particles of unburnt or partially oxidised coals in the clinker, which, by the subsequent action of water and oxygen, caused local expansions, resulting in stresses sufficient to break up the concrete.

AT a recent meeting of the Toronto Section of the American Institution of Electrical Engineers, Mr. A. S. Robertson, of the Queenston power plant, read a paper on the cavitation of large turbine runners. He said that the Commission was experimenting with a surface coating of one or two layers of stainless steel to protect the runners, and that while it was too early to make any positive statements, a particularly rapid pitting runner which was partially treated with a stainless steel weld, after four months' service, was showing very encouraging results. The stainless steel areas still bore the grinding wheel marks, while the untreated areas had already started pitting. This was especially encouraging as the areas covered with stainless steel were those which were subject to rapid and excessive pitting which usually developed in two years into large holes. These areas were in perfect condition, while, in spite of the fact that the untreated areas were in the slow and only lightly attacked areas, they were showing pitting in some cases to a depth of ¼in. As each layer is laid by the welder it is thoroughly peened with an air hammer to work out the shrinkage stresses in the weld and prevent pulling or warping. The peening also produces a more even surface for subsequent layers, breaks up the slag and oxidised coating of the weld, thus giving a much sounder and homogeneous surface on which to build up the succeeding layers.

## Miscellanea.

THE Red Pier at Douglas, Isle of Man, is to be extended at a cost of £220,000.

A NEW fishery research laboratory has been opened at Hull University College.

TWO of the motor omnibuses of the Salford Transport Committee are being run on creasote as fuel.

A NEW bridge is to be built over the South Saskatchewan River at Saskatoon at a cost of 850,000 dollars.

FOUR tanks, each of a million gallons capacity, are to be erected at Toronto for the storage of gasolene.

AN oil refinery is to be put up at Amherstberg, Ontario, by a United States company. It will cost about 200,000 dollars.

IT is stated that the Bhadraviti Ironworks in Mysore, India, have, during the ten years they have been in operation, cost the State Rs. 4 crores.

THE old—it is only nine years old—D.C. electricity plant at Kroonstad, South Africa, is to be scrapped and replaced by an A.C. plant at a cost of £60,000.

A LARGE printing press is being supplied by a London firm for printing the Danish newspaper *Politiken*. It will be capable of producing 84,000 copies of the journal per hour.

A NEW concrete bridge with a span of 300ft. and 18ft. wide is being constructed to replace the narrow suspension bridge over the Jhore Teesta River between Darjeeling and Gangtok on the Thibetan border.

PLANS are, says the *Daily Telegraph*, under serious consideration in Holland for the construction of a new type of three-engined aeroplane designed to fly the 8000 miles between Amsterdam and Batavia in three days.

A BOULEVARD about 30 miles long by 40ft. wide is to be constructed from end to end of Montreal Island. The cost is estimated at over 10,000,000 dollars. The cost of the lighting system alone is expected to be about 1,500,000 dollars.

THE recently opened bridge over the Noyyal River at Palayakottai, Coimbatore, India, has eight spans of 34ft. each and is 18ft. wide. It is of steel with a reinforced concrete deck and provides an important means of communication.

EXPERIMENTS have been undertaken in Czechoslovakia on roadways made of a compound of cement and powdered glass. After some months' trial it has been found that the new roads are more durable and, in the summer, less susceptible to heat than the ordinary roads.

THE Government of Madras has granted a licence to the Trichur Electric Corporation, Ltd., to supply electricity within the town at 8 annas per unit for lights and fans, at 6 annas per unit for the use of the Government and the municipality, and at 4 annas per unit for other purposes.

A ROAD, 60ft. wide and over a quarter of a mile long, is to be an exhibit at the British Industries Fair, Castle Bromwich, Birmingham, next February. It is to be constructed outside the Fair Buildings, as a practical demonstration by exhibitors in the new section for quarry and road-making plant.

THE new laboratory of the Aluminium Company of America, situated at New Kensington, houses a staff of 150 persons, while small staffs are maintained at five other plants of the company. About 250 men are employed in the research activities of the company, and the annual research expenditure is well over 1,000,000 dollars.

THE hydraulic cranes on the wharves at Durban, Natal, are being replaced by new ones with electric drives. Eleven 4-ton cranes are being put in to replace the smaller hydraulics, and the 50-ton hydraulic is to be superseded by an 80-ton electric crane. A 25-ton floating crane is also being built for the port by Harland and Wolff, of Belfast.

ACCORDING to the *South African Mining and Engineering Journal*, the chief metallurgist of the Rand Mines, Ltd., has been successful in evolving a flotation process that very materially increases the extraction of gold from the ore at the Glynn's Lydenburg. The ore at this mine is pyritic, and carries appreciable quantities of arsenic and graphite.

ON Saturday of last week, December 5th, the new 30,000-ton twin-screw steam Transatlantic liner "Manhatten," which has been constructed for the United States Lines, was safely launched from the Camden Yard of the New York Shipbuilding Company, of New Jersey. She has a length of over 705ft., and is designed to carry about 1300 passengers at a service speed of about 20 knots.

A NEW steel bridge is to be built across the Tigris at Mosul City, and the contracts for its construction have been given to British engineers. The new bridge will have eight spans, each 120ft. long. The superstructure, it is said, will consist of Hopkins standard pattern portable spans built for military purposes during the war and since stored at the War Disposals Depôt at Didcot. The total length of steel work will be 984ft. 6in. and there will be masonry causeways 450ft. long on the left bank and 200ft. long on the right bank respectively. The work of erecting the bridge will be carried out by the Iraq Government, while the contract for the necessary steel work has been awarded to Sir William Arrol and Co., Ltd.

THE Council of the Chamber of Shipping, following its adoption in October last of the report on the World Economic Crisis, which was issued by the British National Committee of the International Chamber of Commerce, has further considered the question of economic and fiscal policy in relation to the interests of the shipping industry, and has decided to continue its interest in this matter. With this end in view, it has formed a small committee, including Sir Alan Anderson, Sir Frederick Lewis, and Sir Ernest Glover, to whom it has entrusted the task of following up the report. This will be done in co-operation with the executive of the Chamber, and with other organisations, representing merchants, manufacturers, bankers, and various interests allied with the shipping industry.

# ARC-WELDED BUILDING FOR THE CANADIAN GENERAL ELECTRIC COMPANY

(*For description see page 617.*)

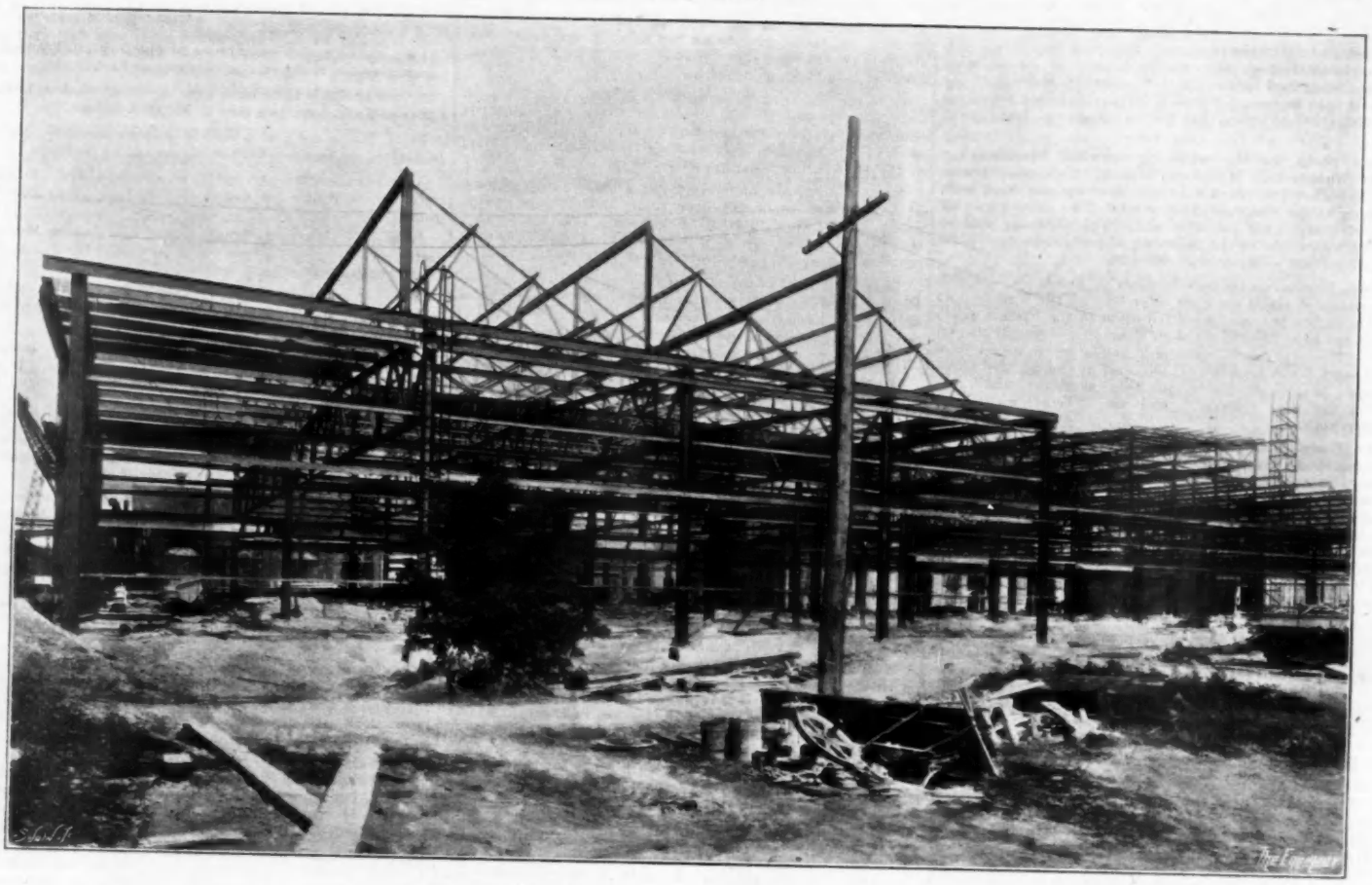


FIG. 4—VIEW OF STEELWORK FROM NORTH-WEST CORNER

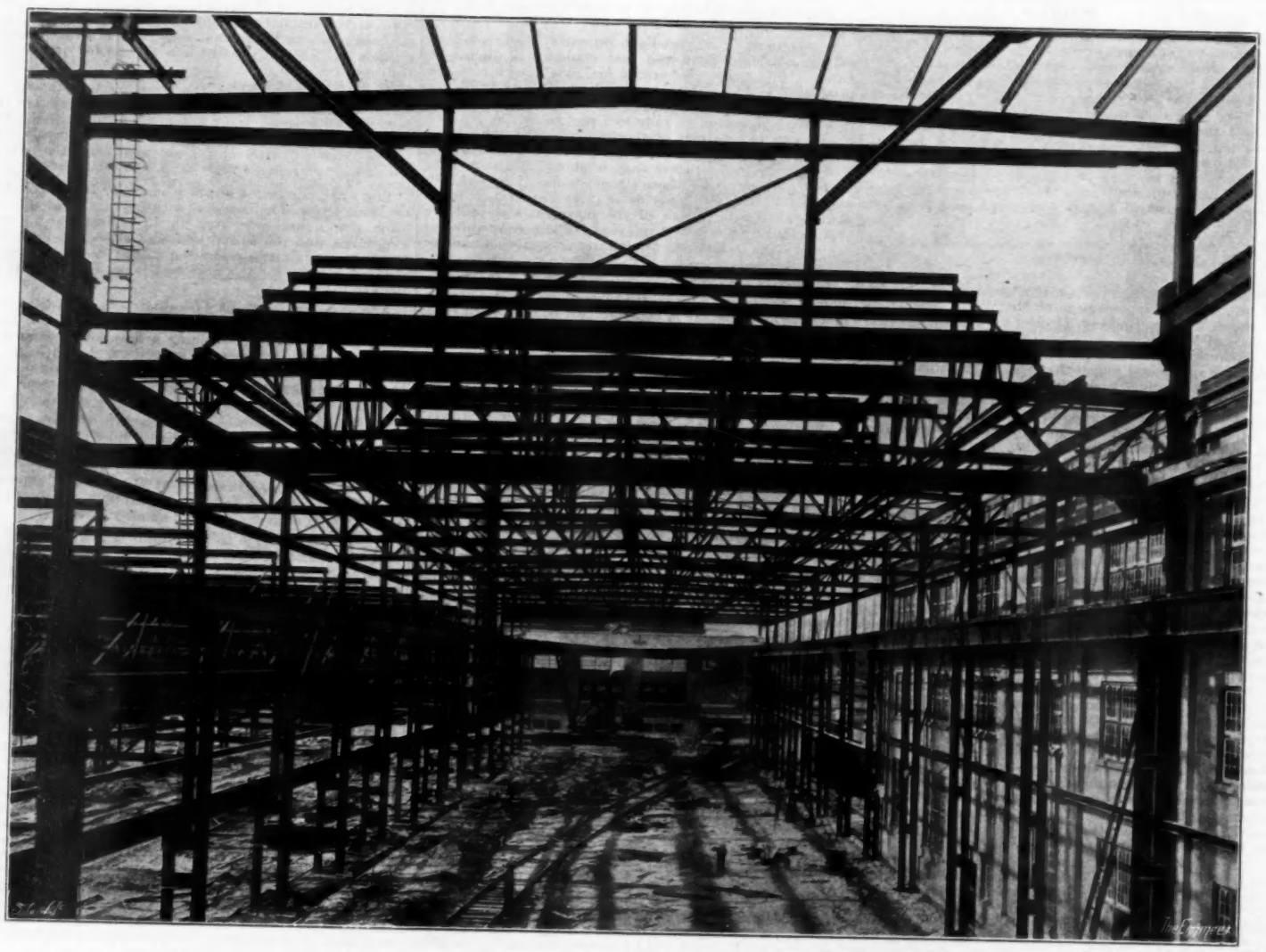


FIG. 5—VIEW OF HIGH BAY AND TESTING SECTION FROM THE SOUTH

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# THE ENGINEER.

VOL. CLII. No. 3961

*DECEMBER* 11, 1931.


### The Generation and Transmission of Electricity.

THE long and informative inaugural address which Dr. S. L. Pearce delivered before the Junior Institution of Engineers on December 4th was listened to with keen interest by all who were present. Some aspects of development in the generation and transmission of electricity, its influence on the design of plant, and the growth in the utilisation of electric power were the matters covered, and a very full account was given of modern power station practice. Great as the changes have been during the President's long association with electricity supply undertakings, he does not believe that finality has been reached, or even prophesied. Looking back some twenty or thirty years, no one who has had anything to do with power stations can easily persuade himself that changes have come to an end, or that works costs will show no further reduction. The changes have been so drastic and so remarkable that old hands in the business are prepared for anything that may happen in the future. That the need for these changes has been very real may be readily seen from a study of figures. Whereas, for example, in 1921, the average coal consumption per kW hour was 3·42 lb., at the end of last year it was 1·9 lb. The last returns of the Electricity Commissioners show that there are still stations operating at very low thermal efficiencies, but coal now forms such a small proportion of the total cost of current obtained from the most modern and best-managed stations, that one wonders how any further improvement in thermal efficiency can make very much difference to the consumers.

As Dr. Pearce explained, substantial improvements in efficiency are sometimes difficult to attain, except at unjustifiable capital costs. Engineers are well aware that to secure the greatest savings in first cost it is essential to employ large generating units, and more particularly large boilers with heat recovery plant in the form of economisers and air heaters, thereby reducing building costs per unit of capacity installed. Dr. Munzinger, the leading authority on boilers in Europe, has stated that the construction of boilers of very high capacities is the most effective means existing to-day for achieving reduction in cost of plant and in the cost of operation, an opinion which has been largely verified by experience in the United States. Hence, the tendency to reduce the number of boilers, and even to use one boiler per generating unit. With that policy little, if any, fault can be found, but, when it comes to suggesting that boilers, and even turbines, should be placed outdoors in order to save money, it is time to set American proposals aside. Even to the much more moderate plan of placing boilers and turbines in the same building without dividing walls Dr. Pearce is opposed, because any financial saving may be outweighed by the additional risk. The only station that has adopted the practice in this country is, we believe, that at Peterborough, where pulverised coal is used exclusively, and there does not appear to be much prospect of the practice extending. As for steam pressures and temperatures, Dr. Pearce explained that it is difficult to draw any accurate conclusions from present movements, because different investigators are inclined to work along varying lines. The present practice in the United States, for example, appears to favour the adoption of pressures of 1200 lb. to 1400 lb. per square inch at a maximum temperature of 750 deg. Fah., whereas, on the Continent, a large number of installations are in service, or under construction, for steam pressures of 350 lb. to 600 lb. per square inch and for temperatures up to 850 deg. to 900 deg. Fah. Although Dr. Pearce had much to say about steam pressures and temperatures his own ideas about the matter are, perhaps, best expressed in the practice which is to be adopted at Battersea, where boilers designed for 650 lb. and a total temperature of 875 deg. are being installed. Concerning generating sets, his opinion was definite and unmistakable. In this country, he said, it was probable that multi-cylinder tandem compounded turbo-alternators having outputs between 50,000 and 100,000 kW would be adopted for base load stations, and if units of that size were suitably operated in conjunction with other units or stations of smaller size, there did not appear to be any immediate need for utilising such large machines as those in operation in America. While Dr. Pearce obviously keeps a keen eye on what is going on in other countries, unlike some, he clearly does not believe that everything that is done abroad ought to be copied in this country, or that continental or American engineering is better than British engineering. Of the suggested methods of dealing with peak loads that of making use of old plant was shown to be by far the most common. By the time it is utilised for this purpose its capital costs have been written off and it forms a cheap source of power for the purpose, although other methods such as that suggested by the late Sir Charles Parsons and Mr. Robert Dowson, in their paper read at the World Power Conference in Berlin, must not be neglected. Whatever difficulties arise in connection with the generation of electricity, schemes are soon put forward to meet them. From the earliest days of power stations those responsible for operating them have met with complaints from people in the vicinity. When stations equipped with reciprocating engines were erected in cities and towns vibration often involved the undertakings in costly litigation; but in these times of super power stations, air pollution is the trouble. No one has better reason to know than Dr. Pearce, how unpopular electrical engineers are liable to become when they propose to erect super power stations in the vicinity of large and important buildings, or in the centre of agricultural districts, or how difficult it is to convince people that chimney emission troubles can be overcome, and it is not surprising that he took pains in his address to clear up any misapprehension that may exist. Effective methods, he explained, are now available for dealing with smoke and ash emissions from chimney stacks. It could also be said that with the fuels used sulphur eliminations of the order of 97 to 98 per cent. had been continuously obtained from the flue gases, and the resultant process effluent could be discharged into the river Thames in such a condition as to conform with the stringent conditions laid down by the Port of London Authority.

The electrical section of the address covered transformers, high-tension switchgear, transmission and railway electrification. As others have done in the past, Dr. Pearce explained that up to the present cables of ordinary design operating at pressures of 33 kV and 66 kV had not proved wholly satisfactory in this country. Troubles arising from the presence of gas films and voids created in the cable by the expansion and contraction of the lead sheathing

have been numerous and indicate the need for further research and improved process of manufacture. On the other hand, in the opening paragraph of a paper on "The Pressure Cable," read before the Royal Society of Arts on November 17th, Messrs. M. Hochstadter, W. Vogel and E. Bowden state that for more than three decades high-tension cables have proved superior to overhead lines as regards reliability. Cables working at the pressures mentioned may have left something to be desired, but it remains to be seen whether overhead lines, which are more or less new in this country, are going to provide the continuity of supply which British consumers expect. Experience up to the present has shown that the overhead system is not devoid of trouble. In parts of Essex, for instance, consumers have recently had to resort to lamps and candles on several occasions, and it would be a bad thing for the electrical industry if that should become a frequent occurence.

### Rural Electrification in France.

THE programme of rural electrification in France has made less progress than was expected when the scheme was instituted ten years ago. About two-thirds of the communes throughout the country are now supplied with current, but most of the installations have undergone heavy depreciation as a consequence of doing the work with insufficient funds, whilst the result of employing cheap material is that the cost of upkeep, after a few years, has added considerably to the charges of the distributing companies. The conditions of rural distribution are entirely different from those in industrial areas. The mains have to be carried over wide territories offering sometimes topographical difficulties, and branch lines must be carried to farms, the cost of so doing falling upon the consumer. Then the distributor finds it necessary to impose a minimum charge, with a scale of rates which diminish with increased consumption. These conditions, which are perfectly normal in industrial districts, are not acceptable to rural communities. The farmer, for example, will not sign a contract under which he is obliged to pay for an amount of current that he is not sure of being able to use; nor is he disposed to pay for a branch line to his farm. Apart from the supplying of light and power to villages, rural electrification is a purely agricultural problem, and the difficulty lies in the extreme variation of loads, the peak being reached during a few weeks in the year when energy is required for ploughing, which, for a depth of 12in., takes an average of about 100 kWh per hectare, or 2½ acres; but the distributing companies cannot afford to install high-tension mains capable of carrying the energy required at the peak in the event of all farmers employing electricity for cultivation. The problem therefore is not easy of solution, as was abundantly shown by the discussion last week at a Congress organised by the Fédération Nationale des Collectivités d'Electrification et d'Améliorations Rurales, and held at the Société des Ingénieurs Civils. Other subjects, such as drainage and irrigation, were dealt with, but electrification occupied most attention, for the reason that it has reached a point where the whole system must be reduced to a workable plan in order to avoid possible failure. This is all the more urgent in view of the expenditure of 300 million francs which Parliament has sanctioned for rural electrification under the scheme of public works which are to be put in hand for the relief of unemployment.

The greater part of the upkeep of rural transmission lines is due to the necessary replacement of wooden poles, whose failure is attributed to the poor quality of the timber that was available soon after the war, when large quantities of poles were bought for rural electrification. In some cases lines have been thrown down by storms. It is not proposed to exclude wooden poles for low-tension mains when they are properly treated and tested, but at present they are being replaced nearly everywhere by reinforced concrete standards. Steel standards and tubular poles are used, but no definite conclusion has been come to regarding the best and most economical system of standard for rural electrification. More experience is needed with this and other parts of the electrical equipment, which is undergoing a continual transformation. What experience has been gained shows that simplicity and solidity are necessary in the construction of rural plants. The main objects in view are to reduce upkeep to a minimum and to avoid fresh breakdowns in the supply, for much of the reluctance to adopt electricity for power purposes on the farm is due to interruptions, and instances are given of consumers who have abandoned electricity for that reason. Electricity is successful for lighting in villages and communes, but it has a strong competitor in the oil engine for power uses, and those interested in electrical development have therefore to investigate every possible means of getting down the cost to a point at which the oil engine is eliminated as a competitor. If the cost is approximately the same, electricity, it is affirmed, will have a preference on the ground of convenience and reliability. The discussion at the Congress was largely devoted to the methods that might be employed of fixing rates in order to overcome the objections and prejudices of rural consumers, but little could be suggested in the way of reducing existing rates, which are much too high. This has always been the trouble with rural electrification, and has so retarded development that the French Government proposed some years ago to offer specially low rates to rural consumers, and to make good the deficit by increasing the rates to users in industrial areas! The arrangement was naturally rejected by those who were required to make a sacrifice in the agricultural interest. Rural electricity supply must pay its own way, but it labours under the drawback of high capital charges, high depreciation, and a net return which is about one-half of that secured from industrial supplies. The only way to improve the situation of the syndicates and companies that distribute electricity is to increase consumption by convincing rural consumers that they can realise economies by employing electrical energy for all the work of the farm. There are not wanting elements of propaganda and co-operation which are working to that end, and yet the results achieved fall short of success. The whole scheme is founded on co-operation, for users must constitute groups to secure the financial aid which the State offers for rural electrical equipment. It is hoped to increase consumption by co-operative ploughing with electric cable tackle, but whilst the few societies that already exist for that purpose have shown the way they have failed to attract followers. It must be remembered, moreover, as we have already pointed out, that if all ploughing were done by electricity the distributing companies would find it anything but profitable, since they would have to lay themselves out to supply several times the normal load during a very short period of the year. Hence they only undertake to supply energy for ploughing and thrashing in particular districts at specified times, and such restrictions are fatal to the success of any plan to extend the use of electrical energy to farmers.

The conclusion come to by the Congress is that there should be a technical staff in each district to advise farmers upon the powers and types of electric motors they should use, in order to get the most economical results, and that the supply companies should adapt their methods to a class of rural users who refuse to accept what is, to them, a complicated system of rates. Makers of electrical and agricultural machinery must also help the farmer by standardising sizes of electric motors and adapting machines for their use, but even on these matters there are insufficient data, and a good deal of experience will have to be acquired before the electrical equipment of farm machinery is quite satisfactory. It was hoped that a further means of increasing the consumption of current would be provided by inducing farmers to carry on some of their work at night, when current would be supplied at a very low rate, but little can be done in that way beyond such operations as water elevation, though it is possible that an accumulation of this cheap energy during the night may find a limited application. Notwithstanding the difficulties that have allayed the original enthusiasm for rural electrification, the French system will be completed within the next three or four years, by which time it is possible that means may be found of extending the use of electricity on farms in competition with oil engines, whose improvement has changed the problem of cheap power since the electrification programme was put in hand ten years ago.

## Literature.

*Faraday and His Metallurgical Researches.* By SIR ROBERT A. HADFIELD, Bart., D.Sc., F.R.S. London: Chapman and Hall, Ltd. Price 21s. net.

SIR ROBERT HADFIELD'S new book possesses far more value to metallurgists than its title implies. No adequate history of the origin and development of alloys has as yet appeared, and even the more limited subject of the ferrous alloys still awaits its historian. Yet when, if ever, that stupendous task is essayed, "Faraday and His Metallurgical Researches" will be found to be a source of valuable information as to early work on alloys of iron and steel, and still more so on the methods and resources of modern metallurgical research work which has been brought to bear on work of the past, but which is in itself a striking testimony to the advance which has been made since the time when Faraday pursued his labours of love at the laboratory of the Royal Institution.

That Faraday was a metallurgist, as well as a chemist of the first order and an eminent physicist has, of course, been recognised for years past. His achievements in metallurgy have, however, been somewhat overshadowed by his discoveries in electricity, and in particular by his enunciation of the principles of electromagnetic induction. Sir Robert Hadfield restores the right perspective and shows us, moreover, how Faraday narrowly escaped making discoveries in metallurgy second only to those he made in other branches of science. Had the incentive and the means been in his day commensurate with those of only a few years ago, there is little doubt that he would have added to his laurels the discovery of those heat and corrosion-resisting steels upon which modern power engineering is depending for future developments which will do for that art what Faraday's outstanding discovery has already done for electrical engineering. It will, indeed, be found, on reading the book, that, premature as such a discovery might have been, Faraday only just missed making it.

The story of the discovery of the wooden box in which were found seventy-nine specimens of alloy steels, and bearing on its cover a label in Faraday's own writing, has already been told by Sir Robert in a paper read before the Royal Society by him in June last. That paper gave details of the research work carried out at the Hadfield Research Laboratory on the identification, chemical and micrographical analysis and examination of the physical properties of the specimens. Those details have been considerably amplified in the present volume, which contains, in addition, reports on similar investigations on nine further specimens which were found subsequently at the Science Museum. The book, indeed, exhibits Sir Robert in a new light; that of a detective following up the clues that led to the recovery of the specimens, and piecing together such other clues, from Faraday's own note-books and diaries, which might serve to identify, with his recorded researches, the confused jumble of tiny "ingots," "billets" and "blooms" found, all mixed together, in the famous box. The result is one which places metallurgists in a state of very real indebtedness to him, not only for bringing before them the results of Faraday's own work, but for the painstaking investigation he himself has carried out under difficult conditions, and the valuable conclusions he has reached. The book is a noteworthy contribution to a fascinating branch of the increasingly important study of alloys in general and of alloy steels in particular.

The range of alloys which Faraday studied was extraordinarily wide. He appears to have been attracted to their study originally by the desire to investigate the nature of the celebrated "Wootz" steel, and to try to find whether it could be reproduced commercially in this country. Whether steel be hardened by the addition of other constituents besides carbon seems to have been another problem that inspired the investigations which led to the preparation of the alloys described in the book. There was yet another incentive to research. Faraday sought to produce a ferrous material which should have, and keep, a "mirror" like surface. In this he was groping in the dark, yet he made some alloys which partly fulfilled his requirements, and in his experiments with chromium just missed discovering the "stainless" group of ferrous alloys which possess such promise in modern engineering developments. The experiments he made and some, at least, of the results he obtained, were published in the paper which, in collaboration with Stodart, he contributed to *Philosophical Transactions* in 1822, entitled "On the Alloys of Steel." In after years he published a few other metallurgical researches, but these shed little new light on the problems which seem to have prompted his earlier work. But for the present book these researches would have been forgotten, while but for the further researches which the author has carried out on the specimens of Faraday alloy steels which he has rescued from the practical oblivion in which they lay buried, neither the nature, the composition, nor the physical properties of those alloys would have been made known.

The alloys made by Faraday, with the very inadequate appliances at his disposal, comprise the binary alloys of iron, for which material of wonderful purity for his time was prepared by him, and what, in the light of our present-day knowledge of steel must be regarded as ternary alloys, consisting of steel *plus* an added metal. The metals added included gold and silver, the platinum group metals, nickel, chromium, and copper. His diaries record the preparation of some alloys containing, in one case, 50 per cent. of platinum, and in another 50 per cent. of rhodium, a new element in Faraday's time, of which a supply was generously placed at his disposal by the celebrated Wollaston, its discoverer, who likewise discovered palladium. No alloys containing these high amounts of the added metals were found by Sir Robert Hadfield amongst the seventy-nine specimens in the

original box. They were ultimately found amongst the remaining nine specimens which turned up later, when it was found that the amounts of platinum and of rhodium in them were rather less than those aimed at by Faraday. Amongst this batch was a 22·7 per cent. palladium steel.

All these steels had, first of all, to be identified, and to do this spectroscopic analysis was resorted to. The value attaching to the specimens, both from a historical and from a sentimental point of view, necessitated scrupulous economy in the use of the material. How meticulously this was observed may be gauged from the fact that whereas the seventy-nine original specimens weighed in the aggregate no more than 7 lb. 14 oz., only 1 lb. 3¼ oz. of the precious material was used up in the investigations. Yet no less than 634 separate tests were made, of which 434 were chemical analyses. The mechanical tests on such minute portions as were available were carried out by means of the Hounsfield "Tensometer." Portions used for one purpose were again employed for others. The need for economy controlled the entire scheme of operations, and metallurgists and chemists will readily appreciate that in carrying out such extensive investigations on such exceedingly small amounts of materials—even Brinell tests were made—the degree of manipulative skill displayed and the inventive resource used must have exceeded even that of the original and famous "chemical manipulator" who had prepared the alloys, although, of course, present-day methods and appliances have advanced far beyond any dreams which Faraday himself may have had of the possible developments of the future. Sir Robert, in his account of the experiments made, recognises in generous terms the help of his scientific staff, a recognition which is obviously due when the skill displayed in getting such comprehensive results from so small an amount of material is remembered.

The plan and lay-out of the book is very good. After a brief introduction, the author passes into *media res*, with an account of Faraday's early life and of his career at the Royal Institution. In this chapter Sir Robert has not been content to recapitulate what was already known, but has shed a new and useful light on the circumstances surrounding his hero's life, and in particular on the reasons which led him to embark on his "metallurgical researches." Another chapter is devoted to accounts of the careers of some of Faraday's contemporaries and of those immediately before and after him who worked along the same lines, or whose lives made contact, in some particular, with that of Faraday. Amongst these are Count Rumford, the founder of the Royal Institution; Sir Humphry Davy, to whom Faraday served a long and not altogether painless apprenticeship; Wollaston; Stodart, respecting whom Sir Robert Hadfield seems to have elucidated all that is worth knowing; Percy; and, bringing the story nearer to our own era, Tyndall. In the succeeding chapter some still earlier workers in metallurgy are discussed, and, in both, following the custom adopted in previous works of his, the author presents a great deal of interesting material and includes a number of portraits.

In a chapter of nearly 100 pages, yet none too long in which to do his subject justice, the author gives a detailed account of the actual research work carried out on the specimens, and gives, moreover, a full description of the chemical methods employed in making the necessary analyses. With so small an amount of material available, doubts might reasonably be cast on the accuracy of the analytical work. In the circumstances, this cannot be challenged. All chemists will recognise freely that that work could not have been done more accurately or with greater care, while the methods themselves are beyond criticism, being the very best at present available. In a succeeding chapter there is a similar account of the work done on the remaining nine specimens which Sir Robert was instrumental in securing, and thus rescuing from oblivion. This set comprised, as has been stated, the high platinum, rhodium, and palladium alloys. From some of these steels Sir Robert has had made a number of miniature penknives, while he was also fortunate in securing a number of razors which Faraday, or some of his friends, had made from alloy steels of which larger amounts had been prepared. Not the least interesting portion of the book deals, as a matter of fact, with the commercial manufacture, on, of course, a comparatively small scale, of "Faraday alloy steels" in Sheffield, where, amongst others, the silver steel alloys appear to have yielded excellent results, which it is a pity were not followed up more energetically at the time. Indeed, Faraday did much more than merely prepare a number of curious and interesting samples. He was able to interest a Sheffield firm in some of his results, and they were repeated, with what appears to have been no little success. Just how, and why, the commercial possibilities of some of his steels were not subsequently more fully ascertained and exploited does not appear. Perhaps the difficulties of preparing metals sufficiently pure for the composition of the resulting alloys to be properly controlled may account for the way in which Faraday's investigations fell eventually into abeyance, or, perchance, the preoccupations of the Master with other lines of research precluded his following up his earlier work on the alloys of steel. In any case it has been left to the last few decades to realise what a wealth of possibilities resides in the alloys of iron—either alone or in conjunction with carbon—and other metals, and this despite not only the early work of Faraday himself, but of other workers, such as the Mushets, who toiled in the same field.

Sir Robert Hadfield records his belief that the birthplace of alloy steels was the Royal Institution Laboratory, and that it is to Faraday that we owe the first systematic research on alloy steels. He also records his gratification that it was in Sheffield that they were first industrially applied "tentatively and temporarily in Faraday's time, but enduringly and ever-increasingly since the 'eighties of the last century." The truth of both these statements may be readily conceded. In the development of modern alloy steels Sir Robert Hadfield himself has played an important part. Metallurgy is now under another obligation to him for rendering available, in so attractive a form, the results of his latest investigations on some of the oldest specimens of alloy steels which have ever come to light.

## BOOKS RECEIVED.

*The Monopoly of Credit.* By C. H. Douglas. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 3s. 6d. net.

*Company Accounts and Balance Sheets.* By K. and M. Moore. London: Jordan and Sons, Ltd., Chancery-lane, W.C. 2. Price 5s. net.

*Highway Curves.* Second edition. By H. C. Ives. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 24s. net.

*Kinematics of Machinery.* By C. D. Albert and F. S. Rogers. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 27s. net.

*The Internal Combustion Engine.* By D. R. Pye. London: Oxford University Press, Amen House, Warwick-square, E.C. 4. Price 15s. net.

*Income Tax and the Professional Man.* By K. A. Coles. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 4s. 6d. net.

*Theory of Simple Structures.* By T. C. Shedd and J. Vawter. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 22s. 3d. net.

*Land Ho! The Last of Her Race and the Convoy.* By E. C. Bowden-Smith. London: Simpkin, Marshall, Ltd., Stationers' Hall-court, E.C. 4. Price 5s. net.

*Radio Telegraphy and Telephony.* Second edition. By R. L. Duncan and C. E. Drew. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 45s. net.

*Water Diviners and their Methods.* By Henri Mager. Translated by A. H. Bell. London: G. Bell and Sons, Ltd., York House, Portugal-street, W.C. 2. Price 16s. net.

*The Roeblings: A Century of Engineers, Bridge Builders and Industrialists.* By Hamilton Schuyler. London: Oxford University Press, Amen House, Warwick-square, E.C. 4. Price 26s. 6d. net.

*The Influence of Atmosphere and Temperature on the Behaviour of Steel in Forging Furnaces.* By D. W. Murphy and W. E. Jominy. Ann Arbor, Michigan, U.S.A.: Department of Engineering Research. Price 1 dollar net.

## Textile Machine Construction in Russia.

*(From a Correspondent.)*

AN official survey of the results which have attended the efforts of the Soviet authorities to establish an industry for the construction of textile machinery does not lead to any satisfactory conclusions as to the possibility of any material success being reached in that direction in the near future. The actual work of construction has been vested in the Textile Machinery Trust, and in certain works which are not incorporated in that combination. Without any further observations on this point, one may at once proceed to reproduce the substance of the information given by two Russian authors (Messrs. Chernenkoff and Andreef) in a recent issue of the Moscow *Economic Life*.

By way of introduction the authors state that definite achievements have been obtained in the few years during which the construction of textile machinery has been undertaken. The engineering works concerned are claimed to have mastered the construction of some machines which, until recently, had to be imported, and to have become familiar with the production of the individual parts of other machines. The work has been carried out at the existing machinery works where great difficulties were encountered in adapting them to the construction of textile machines, as the engineers and other technical staff were quite unfamiliar with these types of machines and with the technological process of the textile industry, so that, in the initial years, the machines turned out were not of high quality.

The first point dealt with refers to the capital expenditure applied for the construction of textile machines for the cotton, wool, flax, knitting and artificial fibre branches. In these directions the capital outlay incurred in the year 1928–29 is put at 17,926,000 roubles; at 28,533,000 roubles in 1929–30, and at 7,349,000 roubles in the final quarter of 1930, so as to permit of the introduction of the calendar year in place of the fiscal year which had previously terminated with September, while, for the present year—1931—the expenditure was to be 24,482,000 roubles. During the same years, the capital expenditure on the equipment of works for turning out plant for the primary treatment of raw materials was 634,000 roubles, 1,518,000 roubles, 583,000 roubles and 24,710,000 roubles respectively.

It will be seen that the capital outlay on the five groups of machines above mentioned was reduced from 28·53 million roubles in 1929–30, to 24·48 millions in the current year. The authors state that this reduction has arrested the further development of the production of textile machines. In particular, this applies to machines for the cotton industry, the expenditure on which, included in the above totals has been cut down from 22·52 million roubles in 1929–30, to 11·36 millions this year. On the other hand, the outlay on plant for the primary treatment of raw materials, as already mentioned, has enormously increased—for the present year to 24·71 millions.

As a result of the cutting down of the expenditure for 1931, the authors state that works to which had been assigned the construction of machines for the cotton industry have been compelled to turn to the production of other plant, while the other works which had been devoted partly to the output of individual textile machines and details have completely ceased this production.

Coming now to the activity of the ten works embodied in the Textile Machine Trust, it is mentioned that they were to produce machines this year of a value of 82,000,000 roubles, made up of 19 million roubles, or 23 per cent., for textile machines; 5·5 millions, or 7 per cent., for textile machine details; 24·5 millions, or 30 per cent., for machines for the primary treatment of raw materials, and 33 millions, or 40 per cent., for non-textile machines and details. At the same time, the works which do not enter into the composition of the Textile Machine Trust and which had also produced textile machines, have almost completely discontinued this work. Thus, the textile department of the Tulsky works has ceased this production; the so-called No. 7 works has entirely given up the construction of cotton machinery, and the Kalinin works has discontinued accepting orders for weaving looms of the heavy type. Out of the eight works which are not incorporated in the Textile Machine Trust, and which produced textile equipment, only two intend to continue this branch—the construction of knitting machines. The remaining six works have either already changed over to other work or intend to take up the construction of other equipment.

### NEXT YEAR'S REQUIREMENTS.

A tabular statement is given by the authors concerning the numbers of different types of machines which are required in 1932 in the cotton industry (spinning, weaving, and finishing); in the flax industry (hackling, spinning and weaving and finishing), and in the hemp, wool and knitting branches. The total number of types in these branches, which are needed, is put at 302. Of them the works are said to be familiar with 115 types, or 37·9 per cent.; while twenty-two types, or 7·4 per cent. require reconstruction, and 165 types, or 54·7 per cent., have not yet been mastered. It is therefore considered that the textile machine industry will have, in order to deal with the situation, to do more work in the immediate future than it has accomplished during the whole time of its existence. In the case of the textile manufacturing industry, it is stated that it is being carried on at the present time with equipment which has already seen service for over twenty-five years, and that the processes of production are equally out of date.

The real demand of the textile industry for textile machinery next year, as set forth by the authors, represents machines of the value of 271 million roubles. But the Textile Machinery Trust has fixed its programme of production at only 110 million roubles, of which 96 millions constitute orders already accepted by the Trust for the delivery of only two types of machines for the treatment of raw materials, especially bast fibre.

The authors submit that the first obstacle to satisfying the needs of the textile manufacturing industry lies in the inadequate knowledge of the types of machines which are required, and secondly, in the completely insufficient capacity of the works to turn out what the mills need. In conclusion, they make a number of suggestions with the object of bringing about an entire change in the situation.

## SIXTY YEARS AGO.

SLOWLY—but very slowly—the principles of correct sanitation were beginning to be understood and practised in this country sixty years ago. Nevertheless, there were still thousands and tens of thousands of dwelling-houses in the land the sanitary system of which invited the outbreak of disease among their inhabitants. The danger existed not only in dwellings of the poorer class, but in many of the mansions of the rich. The highest in the land were exposed to it, and one of them, the Prince of Wales himself, had fallen a victim to it. His Royal Highness had been visiting Lord Londesborough at Scarborough and had contracted enteric fever. Before the Royal visit the drains and water supply of Londesborough Lodge had been examined and had been pronounced perfect. Following it a second investigation revealed features which, in our view, as expressed in our issue of December 15th, 1871, left no doubt concerning the cause of our future King's lamentable illness. The basement of the Lodge, it was found, was traversed by a 9in. drain, and as a dead rat had been discovered beneath the floor, it seemed certain that the drain was leaky. The sewage from this drain discharged into a common drain of porous brickwork, which eventually joined a main sewer discharging into the sea. For a considerable portion of each day the main sewer was tide-locked and the foul air and aqueous vapour within it were compressed to an extent which caused them to break through all ordinary traps. The facts were well known in Scarborough, but, nevertheless, many of the houses were constructed without any provision for the ventilation of the drain. In numerous cases an all but useless bell trap was the only precaution employed to prevent the gaseous contents of the public sewers and cesspools from pouring into the houses day and night. In common with the entire nation, we deplored the Prince's sad illness, but it would, we felt, result in much good being done if it induced local authorities, as it had induced the Scarborough Town Council, thoroughly to investigate the sanitary conditions of their towns. It was an occasion, we contended, for the Local Government Board to show a little vitality. Above all, it would, we hoped, lead the public to exert itself to secure immunity from the dangers with which existing methods of sanitation all too frequently surrounded it.

# The Electrically-Propelled Liner "Monarch of Bermuda."

No. III. (*conclusion*).*

## Electrical Control Arrangements.

The two large control hand wheels, one for each turbo-alternator, which are arranged on the front of the control board, as shown in Fig. 14, operate numerous switching devices in addition to controlling the steam admission to the turbines, as described in our last article. In what follows we describe briefly the sequence of switching operations and the manœuvring controls. These may be quite readily followed from the simplified single-line diagram of connections, reproduced in Fig. 16, which indicates the switch arrangements for the two alternators and the four motors. The starboard alternator—No. I.—and the port alternator—No. II.—are each connected to an independent series of bus-bars arranged within the cubicle, from which they can be isolated by means of the switches Nos. AI. 1 and AI. 2. Each of the four motors is also provided with a two-way isolating switch, Nos. MI., 1, 2, 3 and 4, enabling it to be connected as may be desired to either of the two alternators. The arrangement is one which permits any desired grouping from four motors on the one alternator, to any one, two, three or four motors on the other alternator, thereby making possible the best use of the plant in varied service conditions with a high degree of reliability in case of an emergency. Each motor has also two double-pole contactor switches, 1*a*, 1, 2*a*, 2, 3*a*, 3 and 4*a*, 4, operated by small hand wheels on the control board, which reverse two phases of the motor circuit.

When starting, the propelling motors are designed to operate as induction motors, the sequence of operations being as follows:—The main turbines are first run up to about one-eighth speed without any excitation on either the alternator or the motor fields. The direction contactors are then closed for either ahead or astern running, according to orders, and the speed of the turbo-alternators increased to about one-fifth full speed in order to secure reasonable starting torques on the propelling motors. At this speed the alternator fields are over-excited from the negative booster and the motors begin to revolve, reaching a maximum speed as induction motors, the alternators still running at one-fifth speed. The fields of the motors are then excited from the 220-volt supply through the armature of the booster assisting that supply, and they continue to be over-excited until the motors draw into synchronism with the alternators and continue to run at one-fifth speed as synchronous motors. Further movement of the main control wheel closes the contactor gear and reverses the booster field, thereby allowing the armature voltage to build up in the opposite direction and to oppose the 220-volt supply, which reduces the alternator fields to normal excitation.

The sequence of operations above referred to takes place in subsequent steps over a movement of three-quarters of a revolution of the main control hand wheel in a clockwise direction. Further movement of the same wheel in the same direction controls the admission of steam to the turbines, as described in our last article, which enables the alternators and motors to be run at any desired speed according to the orders which are received from the bridge.

In order to reduce the speed of the ship, or to shut down the turbo-alternators, the same procedure is gone through in a reverse direction to that already described above. The turbines are first slowed down to one-fifth full speed, after which the motor fields are broken and the alternator fields put on open circuit. Reversals are carried out by simply changing over the direction switches operating the reversing contactors, these being housed within the second or high-tension control cubicle.

The four alternative methods of running which are available, along with the corresponding speeds, are attained as follows:—

(*a*) Normal operation: Two port motors fed by the port alternator, and two starboard motors fed by the starboard alternator—full speed of vessel obtained.

(*b*) One port motor fed by the port alternator and one starboard motor fed by the starboard alternator—maximum speed possible about 70 per cent.

(*c*) Four motors fed by either alternator only—maximum speed about 70 per cent.

(*d*) Two outboard motors fed by one alternator and two inboard motors fed by the other alternator—full speed of vessel obtained.

A very comprehensive system of mechanical operating gear is provided in order to enable all the reversing contactors, field contactors, booster connections, &c., to be operated mechanically in the remote event of any of the solenoid operating coils failing. In normal operation, however, all the contactor switches are closed electrically, the mechanical operating gear remaining inoperative. In the event of any one contactor failing to close, the omission is indicated by the signal lamp, and it can then be mechanically closed thereby enabling the remaining operations to be carried out under normal conditions. In order to change the running conditions, it is always necessary to bring back the main control wheels to the "stop" position before the mechanical locking gear between the various switches is free to operate. Mechanical interlocks are provided between the ahead and astern direction contactors, the two main control wheels and all the isolating and emergency-gear operating wheels. It is also necessary for the control wheels to be in the "stop" position before the high-tension cubicle can be entered, entry only being possible by the use of a special key which, until the controls are in the stop position, cannot be released from its position on the control panel.

In addition to the protective features above mentioned, numerous other devices have been incorporated in the scheme with the object of ensuring that any failure of a vital component will not cause damage to the electrical installation. On the booster system contactor-operated protection devices are fitted, while earth and phase faults in the high-tension system are guarded against by a specially designed circulating current type of leakage indicator, utilising relays of the McColl pattern, which have been specially adapted for marine service. There are also load and speed-limiting devices so that, in the case where a single alternator is driving more than one motor its speed is controlled by speed-limit solenoids, which prevent the turbine from being overloaded. In what follows, detailed reference to the various parts of the three control cubicles is made.

Referring to Figs. 14 and 15, it will be seen that the control apparatus is housed in three separate, but adjacent steel cubicles, the first of which forms the actual control panel. These cubicles are arranged at the centre of the main engine-room, the operator having a clear view of the ship's telegraphs. The two control wheels in the centre panels, see Fig. 14, are used for the sequence of starting operations, while the two outer smaller wheels actuate the mechanical emergency controls for the field contacts. Above and outside the main control wheels may be seen the two direction switches, each of which, in normal operation, controls the direction of rotation of two propellers, while, in a corresponding position on the inside of the main control wheels are the two emergency switches which enable all excitation to be instantly removed from the corresponding half of the propulsion equipment. As the main control wheels have a travel of two complete revolutions, a large indicator dial is mounted above each wheel so that the speed setting of the main control wheel may be seen by the operator at a glance. A propulsion motor may be taken out of service by operating the appropriate contactor switch situated just above the indicating dial, while above the contactor switches are the ahead and astern lamps which show the direction of rotation of the main motors. The front of the first cubicle also carries four combined motor and alternator speed indicators, the necessary D.C. instruments for the field circuits, wattmeters for each motor, and A.C. ammeters and voltmeters, while alarm bells and lamps for each alternator are provided to inform the engineer in case of an excitation failure. There are also provided green indicating lamps to show the engineer which of the booster and ventilating fans are running, and temperature indicators for the motors and alternators. The booster field rheostats enable the alternator excitation to be increased if necessary during rough weather. Special stability indicators are provided to indicate the desirability or otherwise of increasing excitation in special circumstances.

As previously described, the isolating switches, for the four motors together with the direction contactors, are housed in the high-tension cubicle, shown in Fig. 15. The four hand wheels of the upper row and the two outer hand wheels of the lower row operate respectively the motor and alternator isolating switches, while the two large hand wheels operate the direction contactors mechanically in the event of failure of the electrical circuits. In order that the operator may know in emergency conditions which direction of rotation is required, signal lamps for each side of the ship are provided at the top side of the cubicle.

The third cubicle, partly shown to the left of Fig. 14, contains all the D.C. switchgear associated with the switching operations of the propulsion equipment, such as machine fields, contactors, together with the discharge resistances, field isolating switches, temperature alarms and protective relays. At the side of the cubicle, part of the mechanical emergency field control gear may be seen. This is continued to the back of the third cubicle, along the top of which

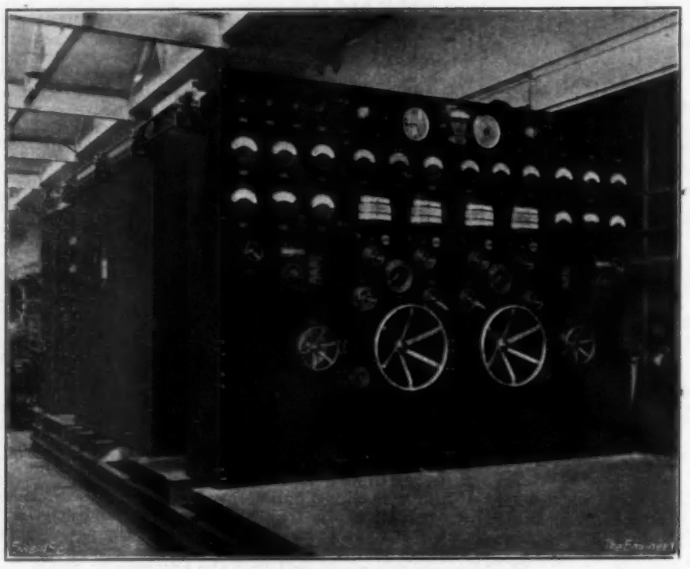


FIG. 14—CONTROL CUBICLES ERECTED IN WORKS

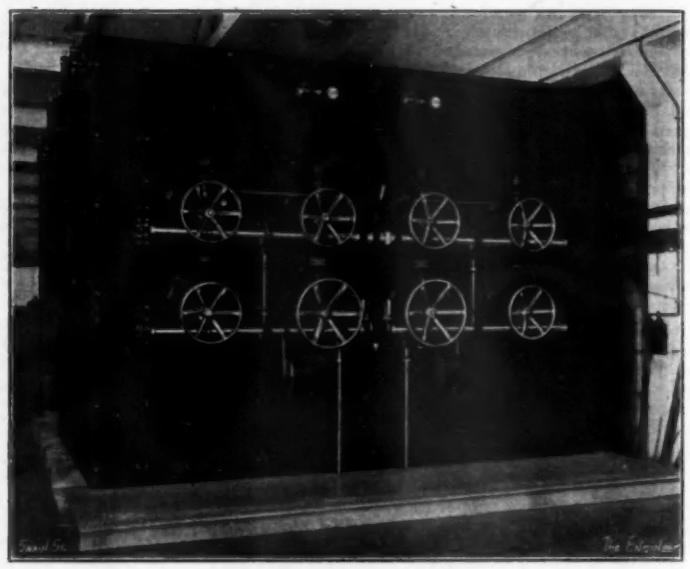


FIG. 15—ISOLATING SWITCHES AND MECHANICAL GEAR

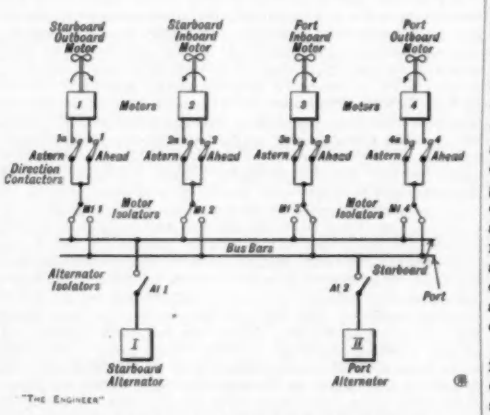



FIG. 16—DIAGRAM OF CONNECTIONS

* No. II. appeared December 4th.

runs a controlling cam shaft for the mechanical emergency gear.

### THE AUXILIARY SWITCHBOARD.

The auxiliary D.C. switchboard is in the auxiliary engine-room, and has a total length of 56ft., there being no less than twenty panels for the different heating, lighting, galley, deck auxiliary machinery, engine-room auxiliary, and propulsion excitation circuits, &c. The four centre panels control the four main generator sets, and for each separate section appropriate measuring and recording instruments and controls are provided. Two interesting features are the G.E.C. plural starter contactor units for the engine-room auxiliaries, and the automatic non-essential circuit tripping arrangement. The plural starter equipment is so contrived that one starter suffices for a number of motors, the starter and its associated apparatus being mounted on the main switchboard, thereby effecting a considerable saving in engine-room floor space. The control unit is mounted directly on the motor and comprises the start and stop push-buttons, the isolating links, and a shunt regulator, together with an ammeter and a pilot lamp. The common starter is on the switchboard and along with it are also the two line and

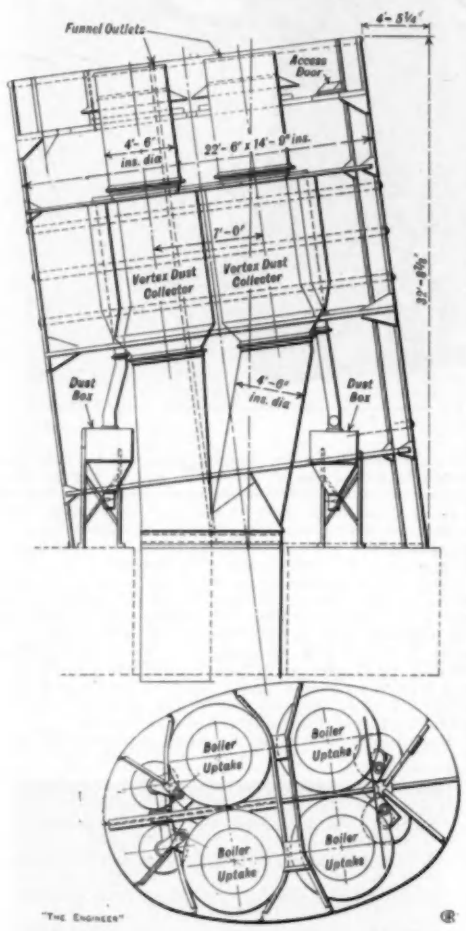



FIG. 17—DUST COLLECTING ARRANGEMENTS

the one starting contactors for each motor, together with the necessary tripping devices and relays. The two plural starter systems on the "Monarch of Bermuda" deal with twelve motors in the main engine-room and seventeen in the motor-room. Each starter can be manually operated in case of an emergency.

In order to protect the ship's auxiliary supply systems, each circuit and each motor in the two plural starter installations is equipped with a special shunt trip, which is connected to one of two bus-bars. Should the auxiliary generators become overloaded, the two bus-bars are successively energised by timing relays. The first bus-bar is energised after an interval of five seconds after the occurrence of the overload, and the second after a further interval of time. When the first bar is energised, the winch circuits, certain ventilating circuits and part of the illumination are automatically disconnected and the current supply to them stopped, while a further group of circuits of secondary importance is cut off as soon as the second bar is energised, leaving only the essential services for the ship's operation, such as navigation, engine-room and skeleton lighting throughout the ship, along with the steering gear, propulsion, excitation circuits, and wireless, &c. This trip gear also enables each generator to be run up to its maximum capacity without endangering the continuity of supply to essential circuits, thereby effecting an economy in running.

In order to maintain an adequate supply of power in an emergency, there is a 45 kW generator set driven by a Fiat oil engine, which is installed on one of the upper decks, well above the water line. This unit has a special switchboard, which is combined with the emergency battery control board, the change-over being designed to take place quite automatically on the failure of the bus-bar voltage. The whole of the cabling and wiring of the extensive installation above referred to, including over 17,000 lights throughout the ship, was carried out by the Sunderland Forge and Engineering Company, Ltd., of Sunderland, the cables being supplied by the associated G.E.C. company, the Pirelli General Cable Works, of Southampton.

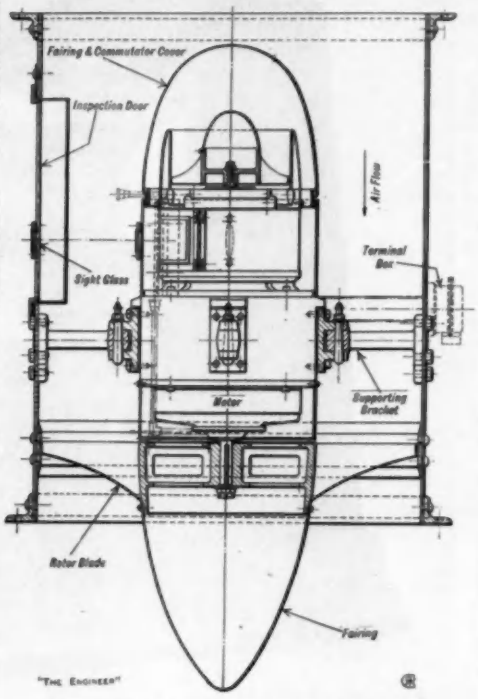



FIG. 18—ENGINE-ROOM VENTILATING FAN

### SOME INTERESTING AUXILIARY INSTALLATIONS.

Among the auxiliary installations which are necessary for a luxury liner of the "Monarch of Bermuda" class we may single out for description the pioneer installation of Vortex dust collectors and spark arresters which have been developed by James Howden and Co., Ltd., of Glasgow, in collaboration with Mr. William Alexander, the patentee of the

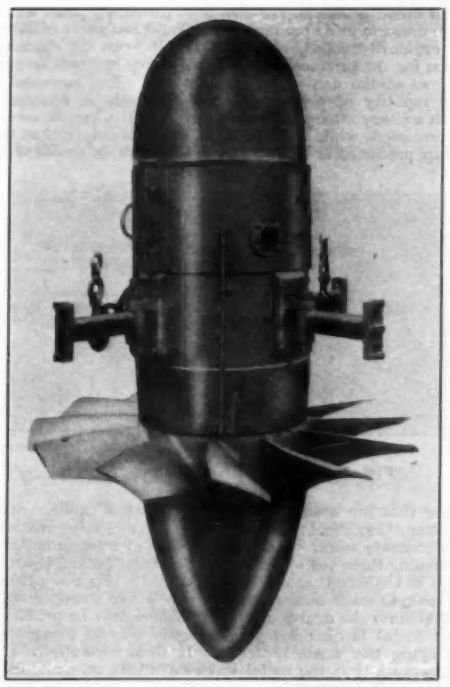


FIG. 19—AEROTO FAN UNIT

Vortex steam separator and dryer. The object of this installation, which, we understand, is the first of its kind to be used aboard ship, although many successful plants of a similar type are running on land, is to obviate any possibility of the sports or sun decks being fouled by minute particles of carbon or dust, or damage being done by sparks. The collector, as will be seen from our drawing Fig. 17, is a cylindrical vessel, there being eight such collectors, four in each of the two funnels, used for the boiler uptakes. The gases from the uptakes are exhausted into the base of the dust collectors, within which a swirl is imparted to the stream of issuing gases by means of a system of vanes. The swirl is sufficient to set up a vortical action, which is intensified towards the outlet from the separating chamber. The impurities in the gases are passed to the periphery of the chamber and enter through a series of holes, the pipe leading down to the dust box, where they are finally deposited, means for their removal being provided. A flange is arranged at the lower end of the outlet pipe, which has been found to increase considerably the efficiency of extraction.

The equipment for ventilating the engine and motor rooms is also worthy of mention, particularly as we found the somewhat confined spaces relatively cool. The ventilation of these important machinery spaces was entrusted to Aeroto, Ltd., of London and Letchworth, and it comprises no less than eight fans of the firm's patented Aeroto screw reversible ventilator type, which are housed in the swivelling cowls on the sun deck. There are four 50in. diameter fans for the turbine rooms and four 45in. diameter fans for the motor rooms. In Figs. 18 and 19 we show a section through one of these fans and the complete fan unit taken out of the ventilator casing. The larger fans have each a designed output of 28,000 cubic feet per minute when delivering against a water gauge pressure of 1½in., while the smaller fans each have a delivery rating of 20,000 cubic feet per minute against the same pressure. The motors were supplied by the G.E.C. Company, and those for the larger fans have a rating of 10 B.H.P. at 635 r.p.m., while for the smaller fans the motors are 6¼ B.H.P. running at 690 r.p.m. The small power which is necessary for the high air outputs may be noted. As our drawing indicates, the rotor of the fan is covered by a streamlined fairing, which is made of spun silicon-aluminium sheet, similar material being used for the fairing at the other end of the unit. The rotor is cast in a non-corrosive silicon-aluminium alloy and is fixed to the shaft extension of the motor. The inner body is attached to the outer casing by the cast steel lugs and supporting arms shown in the illustrations. In order to inspect the commutator of the motor, inspection windows in the commutator cover and the outer inspection door are provided. The cables protrude through the body of the motor and pass through a streamlined cover into the terminal box outside the external casing. As the ventilator cowl can be swivelled, full advantage of the wind velocity caused by the forward movement of the ship can be taken, thereby increasing the volume of air passed for a given expenditure of power.

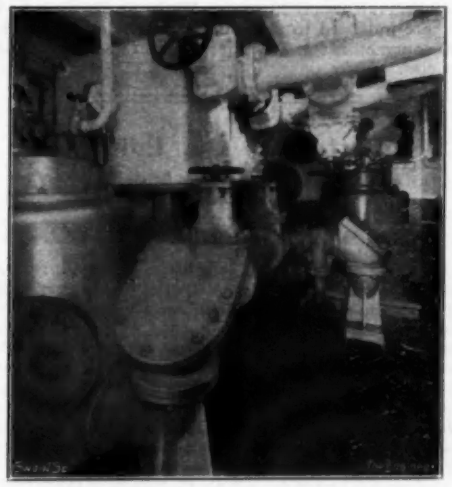


FIG. 20—SEWAGE EJECTOR PLANT

Another feature is the sewage ejector system, which was designed and supplied by the Adams Hydraulics, Ltd., of York. In Fig. 20 we show the sixth ejector unit in the boiler-room, five other units with the accompanying air compressing plants being grouped in the engine-room and fuel tank spaces. Five of the units are of a 65-gallon discharging capacity, while the sixth has a 100-gallon capacity, and each ejector is designed to discharge 40 tons per hour or oftener, if necessary, up to once per minute and even faster for short periods. Each unit is in duplicate and is so designed that the discharge from the baths and wash basins does not normally mix with the discharge from the water-closets before leaving the ejector. In case of an emergency the discharge from all fittings delivering to one unit can be taken to one ejector, the separation of bath water and soil water before entering the ejector being retained. As the ejector fills, an internal float rises, and by opening the air inlet valve admits compressed air, which expels the contents of the ejector; the float then falls, closing the air inlet valve and opening the air exhaust, which leaves the ejector ready for the next cycle of operations. The necessary compressed air for operating the system is supplied by two Broom and Wade compressors driven by 50 B.H.P. motors, which are automatically controlled by pressure regulators which start and stop the compressor sets automatically according to the demand for air.

The controlled discharge of all waste and soil water below the water line is a great advantage for ships so frequently in port as the liner under question.

### TRIAL AND VOYAGE RESULTS.

The official trials of the "Monarch of Bermuda" were, as recorded in our issue of November 13th, very satisfactory, both to her owners and builders, and the voyage round from the Tyne to the Clyde was without incident. The special trials over the measured mile at Skelmorlie were uniformly good, the best run, we are informed, being carried out at a speed of over 20·75 knots. The endurance trials indicated an economical fuel consumption under all operating conditions, reaching as low as 0·74 lb. of oil per shaft horse-power hour, including the propulsion, auxiliary and hotel loads. The hotel load under trial conditions was not, of course, so heavy as that in actual service. The turning and astern trials showed remarkable manœuvrability.

The voyage out to New York was a very good one, in spite of several days of bad weather, during which the ship behaved excellently. She has now completed a round voyage to the Bermudas, and has averaged, we are given to understand, a speed of 19½ knots.

This ship has been much admired by all who have seen her, and she is recognised in America as an outstanding example of British shipbuilding and marine engineering work. She was designed throughout, we may recall, by Esplen, Sons and Swainson, Ltd., of 22, Billiter-street, E.C., and her construction was personally supervised by Messrs. D. Boyd and R. R. Gray Chisholm, of the above-named firm, in collaboration with Mr. E. W. Harvey, the Chief Superintendent of Furness, Withy and Co., Ltd. We are indebted to the builders of the ship and the sub-contractors for assistance given in preparing these articles.

## Letters to the Editor.

*(We do not hold ourselves responsible for the opinions of our correspondents.)*

### INSIDE WALSCHAERTS VALVE GEAR.

SIR,—I should like to congratulate Messrs. Robert Stephenson and Co. and Mr. Molyneux on the very ingenious modification to the Walschaerts valve gear which they have introduced in the Buenos Ayres and Pacific engine illustrated in your number for December 4th, namely, turning the combination lever into the horizontal plane. Besides the use for three-cylinder engines, it can also be applied to ordinary engines with outside cylinders, allowing the valves to return to their old places inside the frames, which will reduce radiation of heat, resistance of the air, and the clumsy appearance of modern engines.

C. F. DENDY MARSHALL.

Guildford, December 5th.

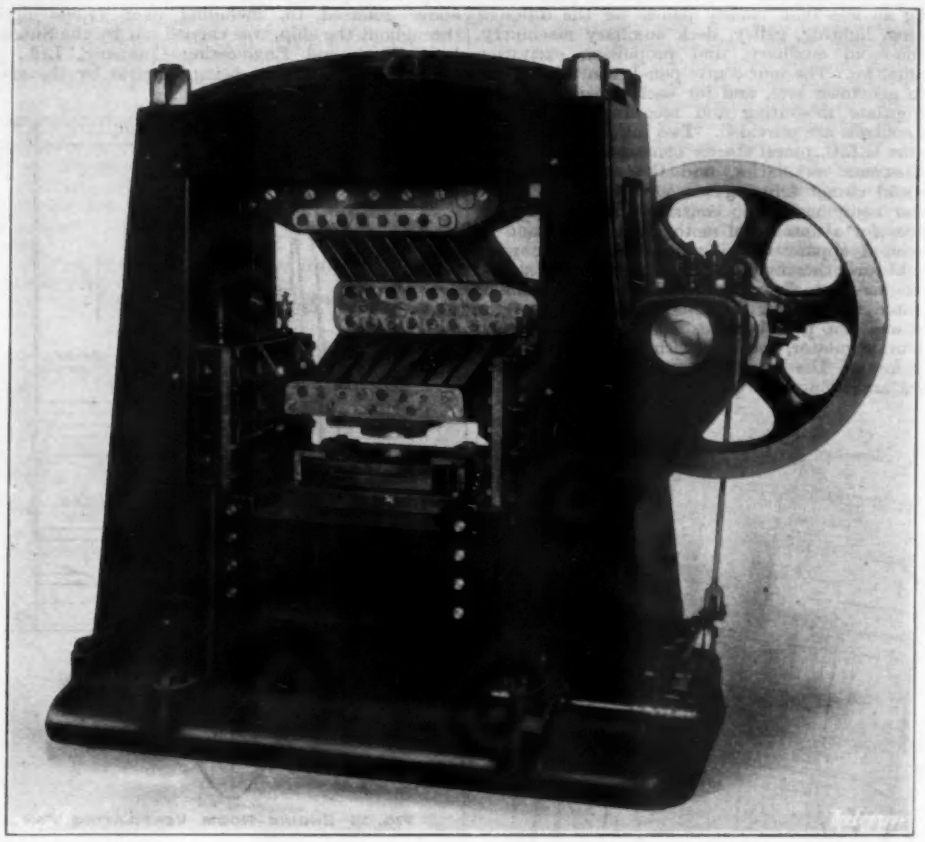
### THE NEWCOMEN SOCIETY.

IT is mentioned in the Annual Report of the Newcomen Society that it came to the knowledge of the Society that Henry Bell's monument, erected by Robert Napier in Row Churchyard on the Gareloch, near Helensburgh, was in a state of neglect. This fact was represented to the Institution of Shipbuilders and Engineers in Scotland, with the result that the monument is now being cared for. Through the exertions of one of the members, Blenkinsop's burial place was located at Rothwell, near Leeds, and his tombstone there was repaired with assistance from the Society's funds. The state in which this and other monuments to distinguished engineers and scientific men have been found by the Society appears to call for action by some public body. The Council expresses a hope that members of the Newcomen Society, at any rate, will exercise vigilance and report any cases of such neglect. In the cases of Maudslay and Symington, the lead given by the Society resulted in adequate public recognition being given. For Maudslay, a memorial service at Woolwich Parish Church, where he is buried, was held on February 15th. Several descendants of the engineer and representatives of public bodies were present. An address was delivered by Mr. F. Carnegie, C.B.E., Chief Superintendent of Ordnance Factories, Woolwich, where Maudslay started life, and a chaplet was deposited on the tomb on behalf of the Society. It is not unlikely that a Maudslay Bursary at Woolwich Polytechnic may be the outcome of this Commemoration. In the case of Symington, the matter was taken up with the Institute of Marine Engineers, with the result that a memorial service was held at St. Botolph's, Aldgate, Symington's burial-place, on March 22nd, when an address was given by Engineer-Admiral Sir Robert B. Dixon, K.C.B., and chaplets were deposited in the church at the foot of Symington's monument. As in past years, a memorial chaplet was sent to his Worship the Mayor of Dartmouth in time to be deposited on Newcomen's Memorial on August 5th, the anniversary of his death. In pursuance of its aims, several objects of technical historical interest have been preserved through the exertions of members, and some of them are now in the Science Museum, South Kensington. The Society co-operated in the Second International Congress of the History of Science and Technology, held in London, June 29th to July 4th.

The Report shows steady progress in membership, which now reaches 321, of which 43 per cent. is outside the United Kingdom. As the Society has always sought to be international in character, this proportion is very satisfactory.

# A NEW TOGGLE PRESS

MASS PRODUCTS LTD., LONDON, ENGINEERS



## The Humphris Press.

SOME six or seven years ago we had our attention attracted to a system of press tool work devised by Mr. Frank Humphris, of Parkstone, Dorset, which appeared to possess considerable merit, and we have followed the idea with some interest. It is, however, only within recent months that the inventor and his associates have, under the name of Mass Products, Ltd., of 75, Victoria-street, Westminster, considered themselves justified in making public the results of those years of experimentation.

In broad principle, the idea is to provide a press which is so uniform in its pressing that a full-sized sheet of metal as ordinarily rolled, say, 6ft. by 3ft., can be operated upon for the production of a multiplicity of small articles at one stroke across its whole width. The increase in the rapidity of production thus attained, as compared with solitary stamping from a narrow strip, can be easily appreciated, while there is the added advantage that the scrap produced is not merely waste, but is provided in

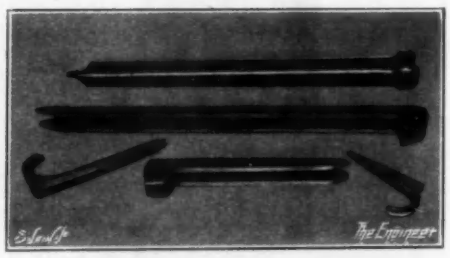


FIG. 1—PUNCHED NAILS AND SPIKES

sizes that are actually merchantable at a profit. Such "scrap," see Fig. 2, may take the form of a reinforcement for concrete work, which is the result of making nails by punching them out of a sheet of metal and folding them to give a U-shaped cross section—Fig. 1. In the process of making washers, for nut and bolt work, a residue very suitable for the drums of gravel washers may be produced and metal lathing for plaster walls can be formed by crimping the waste material. It is noteworthy in this connection that the metal suffers a minimum of internal strain in the process of manufacture.

The press also has the merit that articles of irregular outline requiring different pressures at different parts of their area can be produced without the ram of the machine becoming jammed in its slides. Engineers are, of course, familiar with the difficulty in both presses and drop stamps of keeping the dies truly parallel, even when very substantial guides are provided.

In the press under review this difficulty is overcome by distributing the thrust over the whole area of the platen, instead of applying it, as is the case in a normal press, at one point in the centre. This distribution is effected by using a multiplicity of toggle levers between the head of the press and the platen to provide the pressing force.

The arrangement can be followed in the illustration above, which shows the toggles retracted so that the platen is at the top of its stroke, and in Fig 3. The toggles are all connected at the centre with a plate which is reciprocated horizontally by a connecting-rod and crank, sometimes having auxiliary toggles interposed between them and the plate in order to produce a continuous pressure over the whole length of the stroke.

Each of the toggle levers takes the form of a plate which is wide enough to bear on the full width of the platen and thus distribute the pressure evenly, with all the working parts in compression and no bending. In order to secure this condition it is, of course, essential that all the toggles should be of exactly the same length, and a great amount of study has been devoted to their construction, so that they can be manufactured with the necessary degree of accuracy at a reasonable cost.

Each toggle plate must, of course, have rounded ends

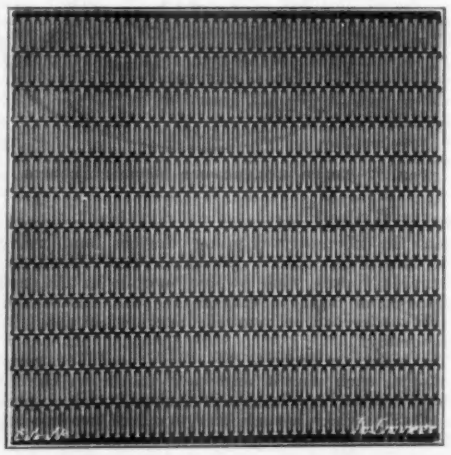


FIG. 2—NAIL SHEET AFTER PUNCHING

to allow it to rock in its bearings, and it was found that if it was attempted to produce such a form by milling it out of a solid plate, the dimensions could not be guaranteed within the necessary limit, which is less than one-thousandth of an inch. However, by using a multi-part toggle plate, having secured thereto two cylindrically formed bars, the desired result was obtained. If there is any slight inaccuracy in the length of the toggle plate itself, it can be corrected by grinding. In this way it is possible to make a group of, say, a dozen toggle plates equal in length to at least one-thousandth of an inch in an overall length of anything between 18in. and 24in.

It is a fixed principle in the design of these presses that the bearing pressure of the toggles on their seatings must not exceed from 5 cwt. to 7 cwt. per square inch, which, it is claimed, is a pressure at which the oil used for lubricating the surfaces will not be extruded. Consequently, the lesser inaccuracies in the length of the toggle plates are taken up by the thickness of the film of oil,

and the pressure is distributed really evenly over the whole surface of the platen. And therein, to our mind, lies one of the chief advantages of the press. The operation of pressing is carried out smoothly and without any apparent distress of the parts of the machine. As a test of this evenness of action we tried out a circular punch 8in. in diameter and set it to cut a crescent of about 6in. across the horns in ¼in. steel plate. The punch went through quite nicely and left the crescent "fair," so that it could be matched up against the previous cut. With such an excentricity of loading on the cut most ordinary presses would produce a very distorted cut.

A claim for this type of press, which, although we have not yet been able to substantiate it personally, we fully appreciate, is a reduction in the wear and tear of the dies or tools. There is no violent blow on the tools which would result in their being embrittled, with a corresponding reduction in their life. The Humphris press also provides an incidental advantage. The total absence of a blow at the moment of operation obviates the necessity for heavy foundations, and quite large machines can be bolted down on to the floor without special precautions.

It will be appreciated that in order to secure the full advantages of this press in the manner we have suggested, some very special tools, or dies, are required, and Mr. Humphris has exercised much ingenuity in their design. We hope to revert to them on a future occasion.

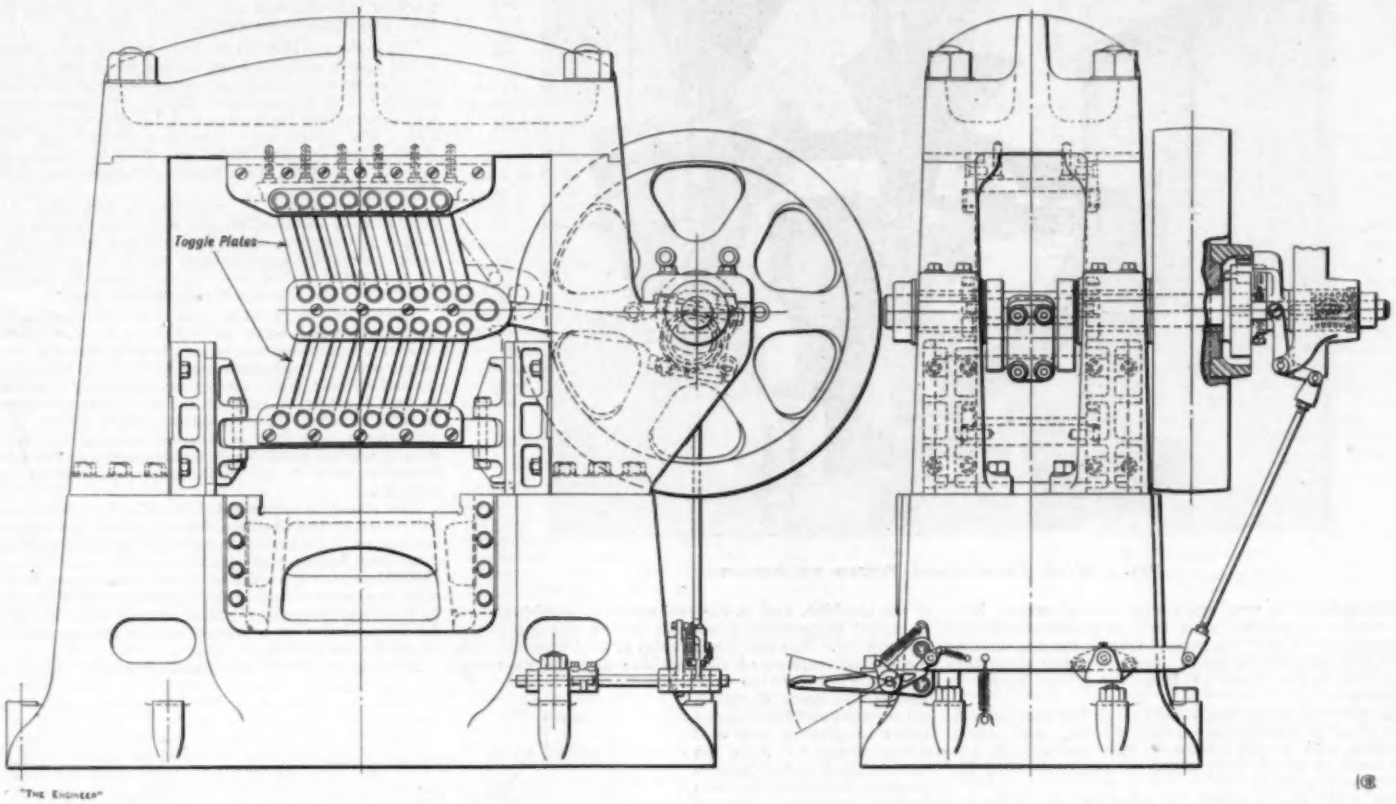



FIG. 3—GENERAL ARRANGEMENT OF HUMPHRIS' MULTIPLE TOGGLE PRESS

## BRITISH STANDARDS INSTITUTION.

*All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.*

### VEGETABLE TANNED LEATHER BELTING.

No. 424—1931. This specification covers the entire process of production from the raw hide to the finished belt, viz., the tanning, currying, and final make-up of vegetable tanned leather belting. Adequate control of these processes is secured by means of suitable chemical and mechanical tests. The specification has been prepared with the full collaboration of the Federation of Leather Belting Manufacturers of the United Kingdom, and the methods of chemical analysis laid down are those which have been drawn up by the Society of Leather Trades Chemists.

### BOILER RIVETS.

No. 425—1931. The forms and proportions of the heads of rivets as purchased from the rivet manufacturer and before closing into the boiler are prescribed by this specification. The standard sizes range from ½in. to 2in. diameter inclusive. Six types of head are illustrated and cover the most commonly used forms for boilers of all types—stationary, locomotive, and marine.

### LATHE CENTRES.

No. 426—1931. The existing divergences and variations in engineering practice with regard to the most suitable angle for lathe centres have recently been investigated by a Committee of the British Standards Institution, and its recommendations have been embodied in British Standard Specification No. 426—1931, Lathe Centres, which has just been issued. Recommended sizes of work centres to be used for various weights of work and speeds of cutting are given in three charts. A critical investigation on theoretical grounds of the comparative merits of the more commonly used 60 deg. and 90 deg. angles is also given in an appendix.

### DIAMOND PYRAMID HARDNESS NUMBERS.

No. 427—1931. The increasing use of case-hardened and high-tensile steels has led to a more extensive adoption of the diamond pyramid indentation test in preference to the Brinell test, with which inaccuracy occurs with high loads owing to ball distortion. This has given rise to the need for recognised tables of hardness numbers corresponding to the British Standard Brinell Numbers, and this need has now been met by the British Standards Institution in B.S. Report No. 427—1931, Diamond Pyramid Hardness Numbers, which has just been issued.

Details as to the method of carrying out the test are laid down and tables of hardness numbers are given for loads of 5, 10, 20, 30, 50, 100 and 120 kilos. A pyramid having an angle of 136 deg. has been specified as the standard, but an indication is also given of the allowance to be made for machines using an angle of 140 deg.

## South African Engineering Notes.

### Cape Town's Air Port.

THE air port for Cape Town, which is being constructed at Maitland, one of the suburbs, is in hand, but will take some months to complete, although considerable progress has already been made. A large hangar has been erected and is ready for use. Some of the smaller buildings, which include an electricity sub-station, a waiting room, petrol store and meteorological offices, have also been completed. Workmen with motor tractors, rollers, &c., were, in the middle of September, still engaged on clearing and levelling the landing field, which, to start with, will be in the form of a circle 600 yards in diameter, with two 400ft. by 100ft. "runways" extending outwards from the periphery of the circle in the direction of the prevailing winds.

### Reef Sewerage Scheme.

As the result of a number of meetings between representatives of the Town Councils concerned, there seems little doubt but that the joint sewerage scheme for Germiston, Boksburg and Benoni will become an accomplished fact. Mr. Lloyd Davies, late City Engineer to the Cape Town Municipality, and Dr. E. J. Hamlin are to draw up a joint report on the scheme, the estimated cost for carrying out which is £750,000. Germiston appears to be quite satisfied that it will go through, for the municipality is already raising a large loan. That town has also completed negotiations with the City Council of Johannesburg for a bulk supply of gas to meet an increasing demand for industrial purposes. It is proposed first to reticulate gas to the industrial areas and subsequently to residential suburbs for domestic purposes, as may be required.

### Limiting Motor Transport.

The legislation which the Union Government has introduced to check the activities of private companies, formed to carry goods in competition with the railways, has been so successful that owners of private motor vehicles have taken to transporting their own goods, and traders have been purchasing motor vehicles specially for that purpose. The Government, therefore, threatens either to grant low tariffs on heavy goods only to traders who convey all their goods by rail, or to include under the provisions of the Road Motor Carrier Transportation Act all traders who use their own motor vehicles. The effect of either of those courses would be greatly to reduce the demand for power lorries, which had been improving.

### Electric Fittings for Johannesburg Station.

A large sum will be required to provide the necessary electrical fittings for Johannesburg's new station. There are 80 miles of telephone wire and 46 miles of other wiring, about 3000 lamps and a power supply that would do credit to a small South African town. The electrical equipment will be as follows:—Solid-drawn and screwed conduit, 66,750ft.; conduit fittings and boxes, 996 dozen tumbler switches, 77 dozen; cut-outs, 46 dozen; distribution boards, 50; lighting points, 2235; power and heating plug points, 57; lighting fittings, 2235; lamps, 2920; lifts, passenger, 3; goods and parcel, 5; book and bullion, 3; switchgear in sub-station, 2200-volt switches, 8; 380/220 switches, 49; transformers, 8; other 30-ampère and larger switches about building, 44; automatic telephones, 176; bells, 75; electric clocks, 80; strong rooms protected with latest type electric burglar alarms, 4; miles of wire, telephones, 80; lighting, 46.

## INSTITUTION OF MECHANICAL ENGINEERS.

ANY doubt as to the wisdom of holding the annual dinner of the North-Western Branch this year was amply dispelled by the success which attended the local committee's efforts on Thursday, December 3rd. The dinner, held as usual at the Engineers' Club, Manchester, attracted an exceptionally large number of members and guests. Mr. H. L. Guy, Chairman of the Branch, presided, and the principal guest was Sir Felix Pole, who contributed an excellent speech on current engineering affairs in proposing the toast of "The Institution of Mechanical Engineers." He said that while the Institution might claim to have raised mechanical engineering to the status of a profession, it had at the same time guarded against the danger of making that profession too "water-tight" in the matter of admission to the Institution. Referring to industrial affairs, Sir Felix said that if we mobilised our resources prosperity would soon return. He considered that the best way out of our present difficulties was to cultivate the production of specialised and refined articles of manufacture. Until two years ago he had been on the side of the buyer of large engineering products, and if anyone had told him then that he bought at factory cost or below factory cost he would have denied it. Having now changed over to the side of the seller, he found that he did buy at what he called perfectly ridiculous prices. As he saw it, the number of big orders was not increased by cutting prices to a ridiculous level, and the buyer himself did not wish the seller to sell without getting a reasonable profit.

The President, Lieut.-Colonel E. Kitson Clark, replied to the toast in a characteristically happy speech. He said that the essence of life to an engineer was that he had problems of science, problems of personality, problems of crises, and problems of change to deal with. In the Institution of Mechanical Engineers they were friends; they met and discussed the problems and difficulties which faced them. They were glad to be able to tell their friends of their successes. They told their friends of their failures, and there was no doubt that sympathy was forthcoming. Sympathy helped a man to try again. In success, the genial friendship and warm handshake of a brother of the Institution of Mechanical Engineers meant a great deal to a man who had struggled through his difficulties. He was heartened and encouraged to try again and double his results. This intercommunication was one of the great merits of the Institution.

The toast of "Our Guests" was proposed by Mr. H. C. Lamb and was acknowledged by Alderman William Walker and Mr. F. S. Whalley, M.C., President of the Manchester District Engineering Employers' Federation. Professor Dempster Smith, M.Sc. Tech., the Vice-Chairman of the Branch, proposed the toast of "The Chairman," Mr. H. L. Guy, and the latter briefly responded. All the speeches were of an exceptionally high standard and the quality of the repast provided by the Club was such as to satisfy the most fastidious gourmet. A collection on behalf of the Institution Benevolent Fund was taken and met with a liberal response.

# A Powdered Coal Plant for Spain.

IN addition to the contract for the conversion of three Babcock and Wilcox boilers at the Randfontein Estates Gold Mine to the Gyro gasifier system of pulverised coal firing, Duffield Coal Products, Ltd., of Imperial House, Kingsway, London, W.C. 2, have just completed and handed over a similar plant at the Central Electric Station Ergobia, Spain, to the order of Messrs. Cementos Rezola, S.A. of San Sebastian.

This generating station was erected to meet the power

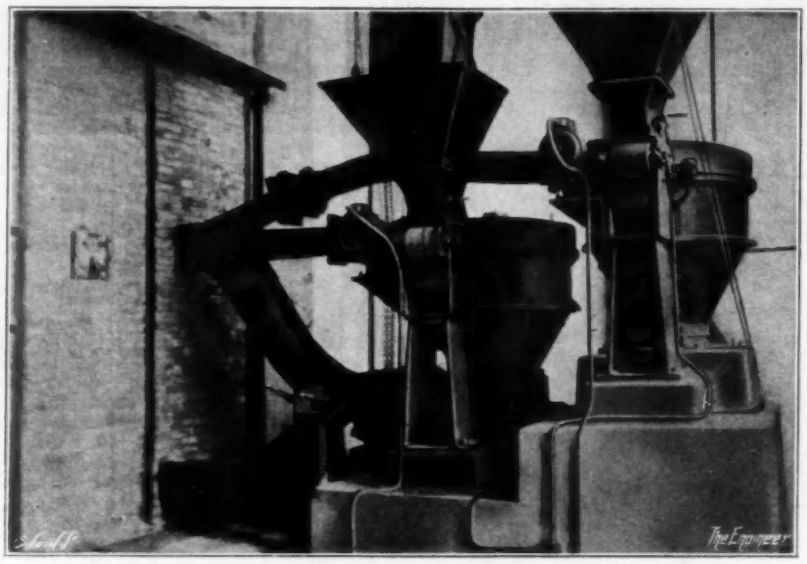


FIG. 1—GYRO PULVERISERS FITTED TO BOILER

requirements of a new continuous rotary cement kiln, and works in parallel with two hydro-electric plants belonging to the same company. During the dry summer months, it also has to supplement the power obtainable from the hydro plant to keep the whole works in operation.

The pulverised coal-firing plant is on the unit system, comprising pulverisers, secondary air fan, and gasifier chambers, and is very similar to that described in THE ENGINEER of March 19th, 1926, in connection with the Dover power station.

The boiler was supplied by Messrs. Borsig, of Berlin-Tegel, and the turbine, alternator and switchboard by Messrs. Siemens Schuckert, Berlin.

The coal used costs 31 pesetas per metric ton delivered, and is dross salvaged from the river banks below a group of Asturian collieries, being largely refuse from the washeries. Owing to its immersion, no fines are contained in it, and the grading is all ¾in. to ⅜in. mesh. The cheapest coals suitable for burning on chain grates or mechanical stokers cost 58 to 68 pesetas per ton delivered to the same site.

The coal is stored under cover, and screened through a ¾in. mesh screen to remove driftwood, &c., before being elevated by a 35-ton per hour elevator to an overhead bunker of 75 tons capacity. It is then fed to the two

The flow of the coal from the bunkers to the gasifier can be traced through the pulverisers by referring to Fig. 2 which shows a sectional view of the Gyro machine. The coal is fed into the hopper A by means of an endless conveyor belt C into the machine at D. The quantity of coal passed is controlled by a damper B, which is operated by a spring-loaded lever. The front pulley of the conveyor acts as a magnetic separator and extracts any tramp iron from the coal. The rejected ferrous material is caught in a sump beneath the conveyor belt.

The primary carrying air for sweeping coal through the pulveriser is controlled by the door E at the bottom of the machine, and as the coal enters it is subjected to an initial separation on account of the draught of the primary air. The heavier particles of coal then fall into the conical portion of the machine and the revolving beaters F throw the coal against the liners G, which are serrated and have special vanes to prevent any coal accumulating to such an extent that churning becomes possible. As the coal becomes pulverised, the upward draught of the primary air separates out the fines which are blown at high velocity by the fan H into the gasifier in the combustion space of the boiler.

The gasifier, it will be seen, is a pot-like receptacle, with an open top and bottom, into which the powdered fuel is blown tangentially. Its outstanding feature is the large quantity of coal it is possible to burn per cubic

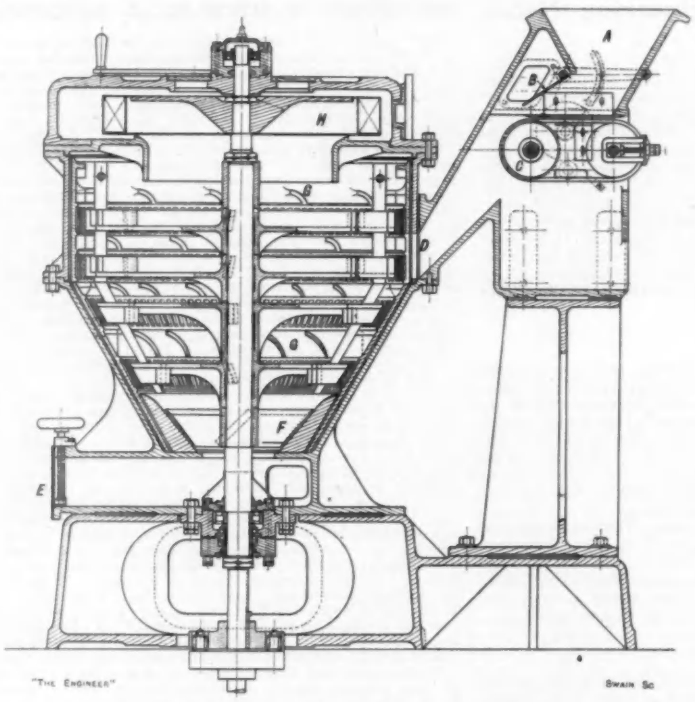



FIG. 2—SECTION THROUGH GYRO PULVERISER

withstands temperatures up to 1800 deg. Cent. The molten ash descending on the gasifier walls is cooled and nodulised by the incoming secondary air, and falls to the ash door in a cooled form similar to pumice stone. The centrifugal action given to the coal particles by the high injection velocity also maintains all particles in suspension until gasification is completed, and the flame emerges from the top of the gasifier in a turbulent form of comparatively low velocity. No trouble, we are told, is experienced in grinding or firing the damp coal, and approximately 75 per cent. of the ash content of the coal is withdrawn from the gasifier base. Analysis shows that the ash has a content of well below 1 per cent. carbon.

The flexibility of the plant is such that the boiler can be maintained at full pressure whilst the turbine is being warmed through, and the pressure held constant as the load is increased to its maximum of 1600 kW.

The boiler is a Borsig two-drum, vertical-tube generator, of 230 square metres heating surface, fitted with an integral superheater and economiser and is designed for a working pressure of 20 atmospheres = 294 lb. per square inch, and a final superheat temperature of 375 deg. Cent. = 707 deg. Fah. The drums are of one-piece construction, and all stand pipes, &c., are welded on. Soot blowers are fitted and all the valves are arranged for operation from the firing floor level.

For the control of combustion, $CO_2$ and $CO+H_2$ recorders are installed, as well as distant reading electro-couple pyrometers, which are arranged in the inlet and outlet passes of the economiser. On account of the height of the water and steam drums, a remote water level indicator is also fitted at the firing floor level.

The guarantees given in connection with the joint boiler and firing plant were as follows:—At normal rating, 7·5 lb. evaporation per square foot of heating surface; 83 per cent. thermal efficiency; 14 per cent. $CO_2$ in second pass of boilers; 4 per cent. maximum loss of combustibles in ash, flue dust and fly ash; 3 per cent. maximum loss in radiation, &c. At overload, the rating is 9 lb. evaporation per square foot of heating surface, 14 per cent. $CO_2$ in second pass, 5 per cent. maximum loss of combustibles, and 3 per cent. maximum loss in radiation, &c.

The steam is superheated to 375 deg. Cent., and is delivered at the turbine stop valve at 350 deg. Cent. maximum. The turbine runs at 5000 r.p.m. and a reduction gear lowers the alternator speed to 1000 r.p.m. Current is generated at 3000 volts, three-phase, 50 cycles, with an exciter voltage of 65. The pressure is then dropped to 220 volts for auxiliaries, and stepped up to 20,000 volts for transmission by overhead lines to the cement works, about 5 miles distant.

Make-up feed water to the boiler is treated in a softening

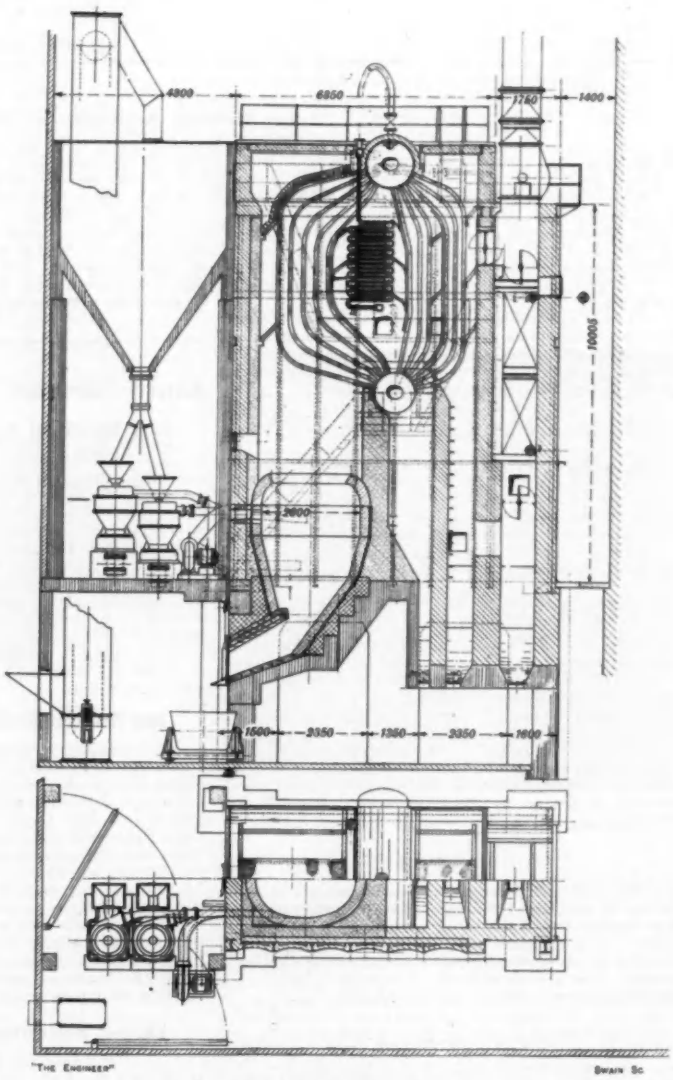



FIG. 3—SECTIONS THROUGH BOILER

Gyro pulverisers in the condition as received, the approximate analysis being 5760 cals., 7 to 10 per cent. moisture, 54·2 per cent. carbon, 20·4 per cent. volatiles, 25·4 per cent. ash, and 1·66 per cent. sulphur.

foot, namely, 10 lb. per hour. As distinct from other pulverised coal-firing systems, the ash in the coal is deliberately fused and forms a protective film on the refractory lining, which is constructed of Leolite. This refractory

plant working on the base exchange principle, and a duplex steam pump controlled by an automatic regulator, feeds the boiler. As a standby, and for starting up purposes, a motor-driven turbo-pump is also installed.

# Provincial Letters.

## THE MIDLANDS AND STAFFORDSHIRE.

*(From our own Correspondent.)*

### Dull Market.

IRON and steel market conditions in the Midlands and Staffordshire show very little change on the week. Demand has not increased in any department, and the transactions which have taken place on 'Change in Birmingham have been few and of small dimensions. The market tone is not so bright as it has been of late, for much disappointment is expressed with the attitude of the President of the Board of Trade to the question of applying an import duty to foreign iron and steel. There has been a widespread belief in the imminence of Government action in support of native producers, many of whom are suffering severely from competition from overseas. Midland works are not so well employed as is usual at this period of the year, and suppliers of material find anticipated sales for pre-Christmas consumption are not being realised. There is an increase of activity in the distributive branches of industry, but little, if any, in the manufacturing section. Consumers of all classes of material are apathetic towards business, and there is hardly sufficient being done to afford a test of prices. Quotations, except in the case of galvanised sheets, which have receded further, are on the same level as a week ago.

### Pig Iron.

The foundry iron branch of the raw iron industry is perhaps responsible for the most activity in the market at date. Steady buying continues, and stocks at the furnaces are being gradually reduced. Moreover, there is a confidence which, though considered by many to be founded purely on anticipation, adds lustre to this section of the market. The light castings trade and the production of products, such as enter into many of the hardware branches in Birmingham and the Black Country, are responsible for the better buying of raw iron. Unfortunately, the great engineering foundries are, with a few exceptions, sparsely employed, and they are consequently but poor buyers. There is a strong feeling in the market that every possible effort should be made to keep selling prices down as the only real foundation for a new trade movement. Smelters themselves are apprehensive of the risks with which a rise in prices would be fraught, but they say that pig iron making at present rates would be unprofitable if coke supplies had to be renewed on the terms which some of the cokeries are now demanding. The furnace coke position is much as a week ago, with no further hardening of prices. Derbyshire and Northamptonshire smelters have in some cases sold their output of foundry iron to the end of January, but they are disinclined to commit themselves beyond this date. Pig iron prices are firm, Derbyshire and North Staffordshire No. 3 foundry at £3 6s., forge £3 1s., and Northamptonshire foundry £3 2s. 6d., forge £2 17s. 6d. per ton delivered Black Country stations.

### Steel.

The demand for steel, whether finished or semi-finished, is poor and patchy. Some fairly good orders have been given out for special steels, such as those used by automobile engineers, but they do not affect the general steel trade. Constructional engineers are not providing much support to the local steel works, while other users of heavy material are likewise unable to consume even a reasonably good tonnage of steel. Mills rolling plates and sections are very slack, and it is with difficulty that plants are kept in operation. Values are firm at recent levels. Angles are quoted at the Association level of £8 7s. 6d.; tees, £9 7s. 6d.; joists, £8 15s.; ship, bridge, and tank plates, £8 17s. 6d.—all subject to their respective rebates. Boiler plates sell at £8 12s. 6d. The market for semis continues more or less stagnant and prices are unaltered. Small bars re-rolled from continental material command £6 17s. 6d. upwards, all-British bars upwards of £7 10s., mild steel billets £5 7s. 6d. to £5 10s., and sheet bars £5 7s. 6d. Staffordshire hoops are £9 10s. delivered. Deliveries of continental material are fairly heavy against old contracts, but local users are not making any fresh commitments.

### Staffordshire Bar Iron.

In the Staffordshire finished iron trade the prospects of revival are slight, and it is as difficult as ever to make arrangements for rolling programmes. The increased momentum noted in the tube strip department some weeks ago is maintained, and a steady output is being disposed of. Moreover, makers have no difficulty in securing their full selling figure of £10 10s. or £10 12s. 6d. per ton delivered. While some mills have for weeks being quoting the lower figure, others there are which are generally able to command half-a-crown per ton above their rivals. Marked bar makers are producing on some three days per week. Prices are firmly held at £12 per ton at makers' works. Crown iron is £9 5s. upwards, and common bars for nut and bolt and hurdle manufacture are £8 7s. 6d.

### Galvanised Sheets.

There is keen competition for a small volume of business in the galvanised sheet industry. While the home market keeps up to recent standards, there is no sign of expansion in overseas demands. Local mills are short of orders, and consequently they continue to give ground when pressed by buyers. Twenty-four gauge galvanised corrugated sheets are now down to the £9 level, and it is reported that where there are substantial shipping orders at stake, offers of rather less than £9 command consideration.

### Transport Rebate.

The arrangement that has been arrived at for the distribution of an additional 2½ per cent. rebate on railway rates for agricultural, mineral and inward iron and steel traffics is welcome to the Midland interests concerned, but they do not consider it provides any great relief. They are thankful, however, for almost anything these days. In the case of iron and steel the relief is given on the raw materials of manufacture transported from their sources to the blast-furnaces. Hitherto, it has been 27½ per cent.; henceforth it is to be 30 per cent. Blast-furnacemen say that the 2½ per cent. increase is equivalent to about 1¾d. on a ton of pig iron.

### University Mining Scheme.

The completion of a scheme for the gradual reconstruction and re-equipment of the Mining Department of Birmingham University, which was initiated by Professor Moss in 1925, will be reached on December 16th next, when Sir Robert Horne will formally open the new ore-dressing laboratory and other extensions. The object of this ore-dressing laboratory is to provide the means for demonstrating ore-dressing processes by a trained staff and also to enable students to conduct these operations themselves. In addition, it provides facilities for research on problems connected with ore dressing. Birmingham University has long been equipped with an ore-dressing laboratory, but, as the plant was installed about thirty years ago and was built to deal with large quantities, it could not be modified so as to afford facilities for demonstrating present-day practice, and it has been scrapped. There has now been installed an entirely new plant, the capacity of which should be in the neighbourhood of 100 lb. per hour, thus enabling a few hundredweights of any particular ore to serve for a number of demonstrations and experiments. The plant has been designed for continuous running, and the flow sheet is such that it can be used for treating the ores of gold and silver, copper, lead, zinc and tin. Provision has also been made for demonstrating the application of magnetic separation to magnetic iron ores, and also to other materials of low magnetic susceptibility, such as wolframite, monazite sands, zinc blende, &c.

### Power from Sludge Gas.

Further plant is to be installed in Birmingham for the production of power supplies from sludge gas. In a report presented to the Birmingham City Council on Tuesday by the Tame and Rea Drainage Board, it is explained that the Colehall works, near Yardley, Birmingham, deal with a population estimated at 100,000, and the dry-weather flow of sewage at the present time is about 2,750,000 gallons per twenty-four hours. With the exception of an experimental plant, there is no provision at Colehall for sludge digestion as carried out at the Saltley works, and a scheme has therefore been designed, and is now in course of execution, under sanction of the Minister of Health, comprising the digestion of sludge and collection of gases evolved in the process and the utilisation of the gas for power purposes on the lines of the plant which is operating so successfully at the Board's main works at Saltley. The gas will be utilised in gas engines, which will, in turn, drive generators, and the electric current thus produced will be employed for power purposes and lighting, and a proportion of gas used in the water-heating system. The plant is designed to treat 50,000 cubic yards of crude sludge per annum. It is anticipated that the plant will be put into commission in the autumn of 1932.

### A Notable Inquiry.

The municipality of Sofia, Bulgaria, has inquired from the British Industries Fair authorities in Birmingham for steel and cast iron pipes and fittings for water supply purposes to the value of approximately £160,000. As Birmingham is the centre of the industry, it is considered just possible that the contract will be secured for this area. The inquiry has been passed to British Industries Fair exhibitors, who make pipes and tubes ranging from hundredths of an inch in outside diameter to 15in. bore steel pipes, as supplied to the Admiralty. Part of the inquiry is for weldless steel piping, some modern adaptations of which, as will be shown at the Fair next year, are for wireless masts, bedsteads, and golf shafts.

### Pumping Machinery for Russia.

Messrs. Joseph Evans and Sons, engineers, Culwell Works, Wolverhampton, have received two substantial contracts from Arcos, Ltd., on behalf of the Russian Government, for heavy pumping machinery for use in the Russian mines and on railways. The order will keep the heavy department going on full time until about Easter. The contract, which was secured in the face of American competition, relates chiefly to heavy mine sinking pumps.

### Foundry to be Extended.

The Black Country firm of Bradsteads, Ltd., Bilston, has secured orders to the value of £40,000 for patented bedstead fittings, which will necessitate the present foundry being extended to double its size. This contract has been obtained in the face of keen competition, both as regards design and price. Mr. W. M. Hughes, a member of the firm, states that extra hands will be required when the extensions have been completed, and possibly the present number of hands will have to be doubled.

### Automobile Firm's Trading.

For the first time in nearly thirty years, the directors of the Triumph Company, Ltd., automobile and motor cycle manufacturers of Coventry, are unable to recommend the payment of a dividend on the ordinary shares of the company. There is reported a contraction of turnover during the past year, especially in the motor cycle section. The profits shown in the accounts amounted to only £6852. It was pointed out in the chairman's report that during the past thirty years shareholders had received dividends amounting in the aggregate to 369 per cent., and, in addition, the capital of the company, out of its profits, had been increased threefold by the distribution of bonus shares.

### Rolling Stock Order.

The Metropolitan-Cammell Carriage, Wagon and Finance Company, of Saltley, Birmingham, has received a contract from the London, Midland and Scottish Railway Company for 108 25-ton all-steel hopper ballast wagons.

### Unemployment.

Unemployment fluctuates somewhat in the Midland area, but in some towns there is a steady decrease, this happy state affecting the Birmingham area, where the figures are now down to 61,254. Coventry returns are also on the right side this week, as are those of Bilston, Derby, Dudley, Leicester, Nottingham, Northampton. Smethwick, Wednesbury, West Bromwich, Wolverhampton, and Worcester. A rather large increase has occurred at Stoke-on-Trent, where the number of unemployed has risen on the week from 32,327 to 34,873. Other areas showing adverse conditions are Cradley Heath, Kidderminster, Leamington and Warwick, Oldbury, Peterborough, Redditch, Stourbridge, and Brierley Hill, Tipton, and Walsall.

### A Busy Factory.

Herbert Terry and Sons, Ltd., the spring specialists, have added a new wing to their main factory at Redditch, primarily for the purpose of installing modern additions to the tool and finishing plants. The new building is admitted to be one of the finest of its kind in the country, and its three storeys have been equipped with up-to-date machines, manned by highly skilled workmen. This costly enterprise is reaping its reward, for not only is the new plant fully engaged, but the whole factory is working at high pressure. Valuable orders have been obtained for the manufacture of articles which hitherto could not have been economically handled. The general office block is being enlarged, and other building operations are in contemplation. At the present time Messrs. Terry's are in the happy position of being able to maintain their three factories running at high pressure, and there is every indication of a continuance of good business. The firm's policy has always been to produce quality goods, and the wisdom of this is revealed in the strong position it enjoys.

## LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER.

### Steel Pit Props.

PROGRESS in the employment of steel props in coal mines is a less rapid process than the steel industry could desire. To some extent, of course, an obstacle to their wider use arises from prejudice, but the Safety in Mines Conference, held in Manchester last Saturday, tended to show that this prejudice is not altogether unreasoned. The Chief Inspector of Mines, Sir Henry Walker, urged that in the movement towards increasing the safety of mines the prevention of falls and haulage accidents is as important a factor as the prevention of explosions, and that the increased employment of steel arches for the support of roads and of steel props for coal faces was important in the prevention of both accidents and explosions. In this Sir Henry secured the unqualified support of Major H. M. Hudspeth, Mining Engineer to the Safety in Mines Research Board, but in the general discussion enthusiasm was qualified. For instance, Mr. P. L. Wood, of Manchester Collieries, Ltd., expressed the view that steel face props should only be used when wooden ones are not giving satisfaction. Mr. John McGurk, President of the Lancashire and Cheshire Miners' Federation, whilst agreeing with the use of steel supports for main roadways, was less convinced as to the desirability of their use at the coal face, his argument being that anything that did not give warning to the miner as it gave way added to his peril, and Mr. F. Edmond, of the Wigan Coal Corporation, asserted that certain types of steel props are a danger in themselves and that the steel strap has a great future.

### A "Grid" Scheme Possibility.

An interesting point emerged from an address to the Manchester Literary and Philosophical Society by Professor H. S. Taylor, who was discussing the extent to which scientific and industrial research work was being prosecuted in the United States. Professor Taylor said that in attempting to find an answer to the question whether heavy expenditure on research paid, he had been asking what were the relative standards of American and British industry, and what major developments had been initiated by each during the last ten years. He was certain that in those industries in which chemistry played a great part dozens of new developments had been initiated by the United States, and he believed that that was true also with regard to the electrical industry. As a case in point, Professor Taylor stated that the American electrical industry was engaged in research with a view to ascertaining whether the alternating system was the best for electric power transmission. If the answer was in the negative, and there was a chance that it might be, the British "grid" system might be out of date by the time it was in full operation. The lecturer's question, "Is not British industry looking too much to Westminster when it ought to be looking to the research laboratory?" might well be the cause of some earnest thinking among industrialists in this country.

### Non-ferrous Metals.

Speculative buying activity, assisted in no small degree by the continued decline in exchange values, has helped to maintain the non-ferrous metals market during the past week, and all sections have been able to finish the week at, or above, the levels current at last report. In the case of copper, no statistics for November have been issued, but it is assumed, with some reason, that the supply position in relation to the demand for the metal is worse rather than better than it was a month ago. The industrial demand in this country has shown little, if any, improvement, but American sales seem to have been a little better and with a somewhat more "bullish" view being taken as to the prospects of output curtailment values

of standard brands have finished up about 12s. 6d. a ton higher than they were a week ago. The monthly tin statistics, contrary to market expectations, showed an increase in the visible supplies of the metal, but the decline in sterling and hopes of better things to come have served to neutralise other factors, including a quiet demand from consumers, and on balance values are no more than about half-a-crown below the high level of a week ago. The demand for lead during the week, both here and on the Continent, has been very moderate, but speculative interests are prepared to take a relatively bright view of prospects and, following the previous week's advance of 10s. a ton, prices have risen by a further 5s. Supplies of spelter at the moment are not too freely offered, and with inquiry for the metal on a somewhat better scale than of late, quotations have been reasonably well held, values at the time of writing being much about the same as they were a week ago.

### Iron and Steel.

Seasonal activity shows indications of developing in the iron and steel markets, especially in the foundry iron section, which has been better situated than others during the past two months or so. The demand has eased off, and whilst up to the present there has been no appreciable decline in the rate at which iron is being called for by Lancashire foundries, Midland makers are already reporting the receipt of instructions to suspend or reduce deliveries over the remainder of the year. A fair tonnage has been ordered for delivery over the January-March period of next year, but there is still a good deal of material to be bought. This business seems likely to be postponed now until after the New Year. Prices are steady at 67s. per ton, delivered Manchester, or equal distance, for Derbyshire, Staffordshire and Cleveland brands of No. 3 iron; 65s. 6d. for Northants, about 87s. for Scottish, and 81s. for West Coast hematite. The demand for bar iron is slow, but prices are maintained at £9 15s. per ton for Lancashire Crown quality material and £8 5s. for No. 2. There has during the past few days been a slightly better movement of boiler plates and of bright drawing bars, but in most other respects the call for steel, both home-produced and imported materials, has been very restricted, with constructional engineers no better placed for work than they have been during the greater part of the past year. Re-rollers are quoting small bars at from £7 to £7 10s. per ton, with boiler plates at £8 17s. 6d. to £9, tank plates at £8 17s. 6d., joists at £8 15s., sections at £8 7s. 6d., and large-sized bars at £9 7s. 6d.

BARROW-IN-FURNESS.

### Hematite.

Business in the hematite pig iron market is quieter, the little spurt in trade which occurred a short time ago not having been maintained and the general demand is at present small. It is fortunate that steel departments in the district have been taking a fair amount of iron, and that demand may, to a certain extent, continue; but there is almost sure to be a stoppage at either one or both mills on railway materials during the Christmas period. Before the end of the year stocks may have increased at some of the works in the district. Both the Ulverston and Cleator Moor furnaces are idle and likely to be with the present poor demand. Trade abroad is thin, which means that foreign requirements are small; otherwise the present price determined by the value of the £ would tempt both Continental and American buyers. Iron ore, both local and foreign, is in restricted demand. The steel trade is not very brisk, but a few orders are still to be secured. The Barrow steel departments may close down for Christmas. They generally do unless they are full up with orders.

## SHEFFIELD.

*(From our own Correspondent.)*

### Progress Still Slow.

THE hopes of a general improvement in the Sheffield steel trades, which have been held so long, have not yet been fulfilled, but progress is reported in certain directions and there is a fair amount of confidence that the New Year will see a turn for the better. Many people hoped that the recent imposition of anti-dumping duties on cutlery and tools would be quickly followed by similar measures with regard to steel itself. The fact that such a step has not been taken by the Government is causing much concern, and the seven Members of Parliament for Sheffield have tabled a motion in favour of immediate measures being taken to protect the iron and steel and other staple industries. The result may be known before these lines appear in print.

### How Things Stand.

In the open-hearth section, there is no increase in production, and some firms are finding it difficult to dispose of their outputs. At the rolling mills, a good deal of short time is being worked, though, in a few instances, these establishments are much better employed than they have been for some time. But a poor trade is being done in tool steels and various special steels, judging by the shrinkage in the demand for ferro-alloys. The heavy manufacturing departments show no progress, and are very short of work. Cravens Railway Carriage and Wagon Company, Ltd., has booked an order for nine ballast brake vans for the L.M.S. Railway, but the shops devoted to the production of axles, tires and springs are very badly off for work. Demand for stainless steel keeps up well, and a considerable volume of parts and special steel for automobile building continues to be turned out. The overseas demand for steel is very slow in responding to the advantageous value of the pound in foreign countries, but that is due to the fact that the buying power of most markets is low Somewhat better business is reported in saws, hacksaws, twist drills and various other kinds of tools. It is now announced that the anti-dumping duties apply to files and rasps, which were not mentioned in the first schedule. That should benefit the local trade, although immediate advantage cannot be expected, as present stocks of imported files are large enough to meet the demand for a considerable period. There was a large increase in the import of these goods during November, in spite of the fact that the suspension of the gold standard meant a 25 per cent. addition to their cost. The imported files sold in this country come mainly from the United States, and there has been no increase in their price so far. Prices of Sheffield files have been falling for some time, and are now very low.

### Valuable Researches.

Some very interesting information with regard to researches carried out in the Department of Mechanical Engineering at the University of Sheffield were given by the Vice-Chancellor—Dr. A. W. Pickard-Cambridge—in an address to the Sheffield Chamber of Commerce last week. He said that an important report had just been issued by the Department of Scientific and Industrial Research, which practically summarised the work that had been done in the Engineering Laboratory of the University over a series of years. The results of the researches had explained very serious difficulties which had been met with in the use of springs, particularly for aeroplane engines and motor cars, and they had also pointed out the direction in which research must be continued and manufacturing processes improved in order to realise improvements that were necessary. He understood that the result of those researches had been to make it possible to foretell with comparative exactness the life of springs in a way which was impossible before. Researches had also been carried out in connection with cold-drawn wires used for ropes and other purposes. They knew how many accidents were due to the failure of wire ropes, and how those failures had often been quite unexpected and quite unexplained. There had been a great deal of co-operative work between the departments of engineering, mechanical engineering, electrical engineering and metallurgy, and a great part of the causes of those failures in wire ropes had now been dicsovered. Again, the researches had indicated the direction in which the matter must be further explored, but there was no doubt that the contribution already made to the safety of human life in mines and other places was very great. Another research was described by Professor F. C. Lea as follows:—"Researches have been continued for a considerable time in connection with the creep of metals. Those have very important applications in connection with the use of all high-temperature plants, and in a fundamental way indicated as far as vessels were concerned the maximum pressures and temperatures that could be used in superheaters, low-temperature carbonisation plants and other vessels for chemical processes. They have also indicated the direction in which new alloys must be developed to meet more extreme conditions, and the experimental technique had made it possible to anticipate at comparatively low cost the suitability of any particular metal to meet conditions of high temperatures and pressures." The Vice Chancellor added that the result had been, he thought, that it was possible to construct boilers which would stand an immensely higher pressure than anything before.

### Smokeless Fuel.

The Salerni process of low-temperature carbonisation of coal, which was described by Professor R. V. Wheeler at the Third International Conference on Bituminous Coal, at Pittsburgh a week or two ago, also owes much to the University of Sheffield. The experimental work on the process was carried out in the Fuel Technology Department of that institution. The object of the process is to produce a smokeless household and industrial fuel of high density, and it is interesting to know that it is to be applied to the coal used on the Italian State Railways. The plant was designed by Chevalier-Commander Piero Salerni, who was expert delegate of the Italian Government to the Pittsburgh Conference. The bituminous coal from which the Italian railway fuel will be obtained is mined in England, and the South Yorkshire coals are particularly suitable for the purpose. Eventually, all the bituminous coal imported into Italy, which is from 15,000,000 to 17,000,000 tons annually, will be carbonised by the Salerni process, with the exception of that which is used for making town's gas. The production of fuel for the Italian railways has necessitated the erection of a control station in England, where coal will be tested and men trained in the work.

### A Shipbuilding Order.

The announcement that Furness Withy and Co. have placed an order with Vickers-Armstrongs, Ltd., for the building of a second "Monarch of Bermuda," to replace the "Bermuda" which was burnt, is of interest to Sheffield. The ship will be built at Barrow, but special and heavy steel work in connection with it should come to the Vickers Works of the English Steel Corporation in Sheffield. Another matter of interest is the intention of the G.W.R. to lay down another 50 miles of track with steel sleepers, 105,000 of which are to be ordered shortly. Sheffield itself does not make these sleepers, but one of its largest concerns—the United Steel Companies—has a branch elsewhere which does.

### Cutlery and Plate.

In most departments of the cutlery and plate trades things continue quiet, but there are some good orders in hand, and a few late season orders are still coming through. Some firms are able to report excellent trade in stainless table knives, but that is not the case with the majority. The scissors department is flourishing, and the production of safety razor blades is on a very large scale. It is reported that the effect of the anti-dumping tariff and the depreciation of sterling, has brought Solingen sales of cutlery to England to a standstill. The anti-dumping duty on spoons and forks will not affect Sheffield much. There is little serious foreign competition so far as nickel silver spoons and forks, plated or unplated, are concerned. Imports from Germany, which have been large and increasing, have been of a very cheap and inferior quality, consisting mainly of tinned steel or nickel-plated steel, or of a low-grade of nickel silver, which would not be recognised in the local trade. These goods would not appeal to the average householder, and they are principally disposed of in the auctions and cheap bazaars. The goods are so cheap that it is doubted whether a 50 per cent. duty will keep them out of the country.

### Lincolnshire Items.

There is prospect of the establishment, by a Dutch firm of tile makers, of a large works at New Holland, Lincolnshire. The district is a well-known brick-making centre, and recently a wagon load of clay was sent from it to Germany for analysis. The satisfactory report upon it has resulted in the Dutch firm opening negotiations for the purchase of 200 acres of land. The site has a frontage of nearly a mile to the Humber, where wharves can be constructed. The L.N.E.R. has been approached with a view to the provision of sidings. Mablethorpe and Sutton Urban Council is concerned about the proposal of the Air Ministry to erect an aerodrome between Louth and the coast, and establish a bombing and machine-gun target ground extending from Saltfleet Haven to a point within the Council's district. The Council has decided that the proposals of the Ministry should be strenuously opposed, as being a hindrance to the further development of Mablethorpe as a holiday resort.

### Water and Sewerage Schemes.

So successful has proved the Alfreton Urban Council's experimental bore-hole at Lea, which is now yielding 600,000 gallons of water per day, that the Council has resolved to bore a further 100ft. It is thought that the extra depth will give greater pressure, and may bring the water level to the surface. The Chairman of the Waterworks Committee looks forward to the time when the Council may be able to sell water instead of having to buy it. At present it pays the Derwent Valley Water Board £12 10s. per day for 250,000 gallons. The Unemployment Grants Committee has approved the grant in connection with the Sutton Bridge Urban Council's £31,000 water scheme for East Elloe, which has now been sanctioned by the Ministry of Health. At a meeting of Staveley Parish Council, the Chairman intimated that there was a possibility of the Government grant for a new water tower at Staveley being withdrawn. If that occurred, he said, it would create a serious position with regard to the water supply of the northern area, although it would effect a reduction in water charges which had been based on the assumption that the scheme would go through. A Ministry of Health inquiry has been held at Clowne, into the application of the Rural Council for sanction to borrow £12,200 for alterations in the sewage disposal works at Clowne, Creswell, Whitwell and Barlborough.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### Cleveland Iron Trade.

THE rate of progress towards restoration of normal conditions in the Cleveland iron trade is decidedly slow, but the outlook is regarded as favourable. Chief interest this week has centred upon the question of tariffs and until the position becomes clearer little business can be expected. However, a quiet period of the year has now been entered upon. For the most part, consumers are not in urgent need of supplies, having covered their requirements to the end of the year, and, as the stocktaking period lies immediately ahead, new purchases are being delayed. Any business that is passing is in small quantities on home account for early delivery. Export trade shows no expansion. Pig iron stocks are gradually decreasing, and though withdrawals are smaller than could be desired, the steady statistical movement in favour of sellers encourages hope that ironmasters may shortly find themselves justified in rekindling idle blast-furnaces. Prices are steady and unchanged, No. 1 Cleveland foundry iron being 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

### Hematite Pig Iron.

There is little change in the position of the East Coast hematite pig iron trade. The demand is quiet, but there are inquiries in the market for larger quantities for January. Prices are steady at 65s. for mixed numbers, and 65s. 6d. for No. 1 quality.

### Iron-making Materials.

Consumers of foreign ore have large stocks and substantial deliveries to take under running contracts. New business is rarely heard of. Best Rubio ore is nominal at 16s. 6d. c.i.f. Tees on a 5s. freight basis. Consumption of blast-furnace coke is very limited, and prices range from 16s. 6d. to 17s. delivered at North-East Coast works.

### Manufactured Iron and Steel.

The state of quietude in nearly all branches of the manufactured iron and steel industry continues. Constructional engineering firms are by far the most important buyers, but, although they are placing orders for a fair aggregate of tonnage of steel, they are by no means anxious, unless the circumstances are exceptional, to depart from their policy of purchasing on a strictly early rolling basis. The outlook for semis is better since the rates of exchange preclude the importation of foreign material. The sheet market is extremely dull, and sales of galvanised sheets at as low as £9 are reported.

### Iron and Steel Imports.

Imports of iron and steel to the Tees last month amounted to 19,005 tons, comprising 280 tons of pig iron, 16,979 tons of crude sheet bars, billets, blooms, and slabs, and 1746 tons of plates, bars, angles, rails, sheets, and joists. Imports for October totalled 15,663 tons, comprising 687 tons of pig iron, 13,595 tons of crude sheet bars, billets, &c., and 1381 tons of plates, bars, angles, &c.

### More Work for Tyneside Firm.

Further apparatus required at the new power station, which is being built at Dunston by the Newcastle-on-Tyne Electric Supply Company, Ltd., is to be manufactured by C. A. Parsons and Co., Ltd., at their Heaton Works, Newcastle. The firm has received an order for the supply and delivery of three 6000-kilovolt-ampère, 13,500/3000-volt transformers, and twenty-six auxiliary transformers at lower voltage ratios. The value of this order slightly exceeds £10,000, and brings the total value of orders received by the firm from the Newcastle Electric Supply Company to nearly £422,000 in connection with the change of frequency in the North-East Coast area.

### The Coal Trade.

There is every prospect of the Northern coal trade experiencing a brisk time to the end of the year. That coal consumers abroad are taking advantage of the low rate of sterling exchange is revealed by orders just reported. Two cargoes, each of 2500 tons, have been sold to Riga, Latvia, with which formerly there was a good trade, but with which business recently has been at a standstill. A cargo of best Durham bunkers has been negotiated for Jamaica, it being the third within a month. A favourable movement is anticipated in practically all sections of the coal trade. The output during the last week of the month will be heavily curtailed by holidays, so that shippers have only the next two weeks to rely on to cover their definite needs for the month. While it is believed that a fairly good trade will be done, there is the limited issue of licences for imports into France and Belgium to contend with, which is expected to check shipments in that direction substantially. The home demand for house coal is increasing, and the general demand, home and export, for gas coal shows improvement. There is no special pressure of steam coal on the market. Wear primes, while readily obtainable, are not in excessive supply, and hold steadily to 15s. for large and 12s. for small. Tyne prime large are sparingly offered at 13s., the bulk of this grade being cleared as unscreened, for which there is a well-sustained demand. Best Northumberland steam coals are steady at 13s. 6d., and seconds 12s. to 12s. 6d. The wintry weather, which has set in sharply in some northern regions, has quickened the demand for Durham gas coals. Best qualities are quoted steadily at 14s. 6d. to 14s. 9d. Secondary gas kinds are a weak section at 13s. 6d. Bunker coals are in better demand for the coaling stations, and orders are being booked more freely for vessels' own use at North-East Coast ports. Best bunkers easily command 14s. to 14s. 6d., but there is a good supply of secondary sorts at 13s. to 13s. 3d. Restricted licence issues for shipments to Belgium and France keep the coking coal trade at a low level, and the minimum prices are easily indicated, unscreened at 13s. to 13s. 9d., and small 12s. 6d. to 13s. Gas coke is readily cleared, and stocks have to be drawn on to fulfil pressing orders. Shipments keep to a good average, and local demand for household use is brisk. Export price holds firmly to 19s. There is not much improvement to note in patent oven coke demand. Stocks are excessive, and prices remain unchanged at 16s., and for superior qualities 18s. to 20s.

## SCOTLAND.

*(From our own Correspondent.)*

### Quiet Markets.

WITH conditions still full of complications, business makes slow progress, and markets generally are, if anything, quieter than they were a month ago. The outlook in some respects may be brighter, but until the ruling uncertainties are removed, trade is likely to be unsatisfactory.

### Steel and Iron.

Makers of heavy steel are not yet able to report progress, and only about 30 per cent. of the plants are in operation. In view of recent shipbuilding orders, it is expected that specifications for plates and sections will soon show some improvement. Sheet makers are better off by virtue of orders secured from the East and Far East. Thin sheets in particular have benefited. Heavy black and all descriptions of galvanised sheets are not particularly well placed, however. With business improving, sheet makers are naturally concerned at the possibility of a duty being placed on their raw materials, and a deputation has already visited the Board of Trade to place their position before the authorities. Steel re-rollers, of course, are likewise concerned. Tube makers have a much better inquiry for their products, but orders are still very slow. The possibility of continental tube strip being affected by an import duty causes some apprehension, as the margin between home and continental strips is so great, even with the pound at 14s. 2d., that a duty of at least 50 per cent. would be necessary to exclude foreign hoops and strips. A feature of some encouragement has been the re-lighting of two blast-furnaces at Gartsherrie, one to produce foundry pig iron and one hematite. Though business in pig iron continues slow, the outlook has improved to some extent, owing to the effect of our depreciated currency on continental imports. The inactivity of home consumers prevents a greater realisation of the benefit, however. The five furnaces in operation are quite equal to the present demand. Bar iron and re-rolled bars show no signs of renewed activity. Prices of the former are unchanged, but the latter is weaker at £6 7s. 6d. home and £6 5s. per ton export.

### Scrap.

The recent sharp rise in scrap is fully maintained, cast iron machinery being still quoted 57s. 6d. to 60s., and heavy steel 40s. to 42s. 6d. per ton.

### Coal.

Business in the Scottish coal market is not only affected by limitation of exports, and higher tariffs abroad, but also by the operation of the quota system. The latter chiefly affects collieries in the Lothians and Fifeshire. In those districts producers have been forced to curtail the working day in order to extend the period of operations, and some have now intimated that work for this month will cease on the 15th. Consequently, there is a possibility of a shortage of fuel required for delivery before the end of the year, and also of supplies for home purposes. Meanwhile, though orders are fairly good, prices are maintained at full recent standards. Lanarkshire splints are well placed at the moment, and East of Scotland steams move freely, but the strongest feature is still treble nuts, especially Fifeshire descriptions. Aggregate shipments amounted to 236,033 tons, against 231,838 tons in the preceding week, and 126,359 tons in the same week last year.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

### Coals for France.

BEFORE the end of last week confirmation was received at Cardiff by the South Wales Coal Exporters' Association that the French Government had decided to curtail imports of coal to 72 per cent. of the average quantities shipped to that country during the three years 1928, 1929 and 1930. This operates as from the 1st inst., and it is stated that it applies to all countries which export coals to France. The news also came through that the French authorities had decided to permit the importation of small coals and duff intended for use for briquette manufacture on the basis of the average monthly quantity for the three years mentioned without deduction. That, of course, was interesting, but, as a matter of fact, the authorities have all along extended more favourable consideration to the classes of coal referred to, since the decree was first promulgated and, furthermore, other countries are more likely to benefit than this country. Since the war exports of these coals and of patent fuel to France have fallen off to a very marked extent so far as this country is concerned. What, however, is causing more anxiety to the trade is the surtax of 15 per cent. imposed by France exclusively upon imports from the United Kingdom. There is evidence that all interested in the coal export trade of this area are very much impressed with the plain speaking of the President of the Board of Trade. The effect of recent restrictions by France has been very clear during the past few weeks, and according to the president of the Mining Association, Mr. Evan Williams, many collieries in the past three weeks had been worked only seven days, whereas before that trade with France had kept them going four or five and even six days a week. Furthermore, the representatives of the British coal trade, when they interviewed the Director of the French Mines Department in Paris at the end of July, were assured that as and from September 1st, when the period of initial concessions and exceptions would terminate, all countries would be treated on an equal footing, but Great Britain was the only one to which the surtax was applied.

### Coal Exports and Contracts.

Last week was a bad period again for the steam coal collieries. The returns of the G.W.R. Company for the six ports under its control show that coal and coke shipments came to only 338,915 tons, which compared with 462,565 tons for the preceding week and with 515,022 tons for the corresponding week of last year. Unquestionably, the facilities for collieries to secure an outlet for their coals were considerably curtailed by the fact that tonnage due to arrive was delayed by the stormy weather prevailing, and the disastrous effect of that will be realised when it is stated that by the end of the week the number of idle tipping appliances at the various docks reached the extremely high figure of sixty-two. This week was started under slightly better conditions, as on Monday this number was reduced to thirty-one; but even that is far from satisfactory. Business for early loading continues to be very dull indeed for all directions, and so far as shipping is concerned, outward freights are as depressing as ever they were. Contract operations claim a certain amount of interest, but exporters are faced with great difficulty as to base on minimum coal prices and current rates of freight is a definite risk, since it is certain that shipowners cannot continue for ever to run their tonnage at a loss. The Brazilian Central Railways are in the market for 100,000 tons of steam coals, consisting of two-thirds large and one-third smalls for delivery over three months at Rio de Janeiro; but here, again, the question of payment is a very important factor in accepting this business. Tenders were also opened at Cairo on Tuesday for 140,000 metric tons of locomotive coals for the Egyptian State Railways for delivery at Alexandria from February to June next. The railways also asked for prices for 35,000 metric tons on an f.o.b. basis. The lowest offers tendered were 24s. 11d. c.i.f. by two firms—Gueret, Llewellyn and Merrett, Ltd., and T. Beynon and Co., Ltd., of Cardiff, while the former offered the coals on an f.o.b. basis at 17s. 9d. and the latter at 17s. 7d. per ton. Other offers on a c.i.f. basis ranged up to 25s. 11d. The prices have to hold good for fifteen days. The expiring contract executed by T. Beynon and Co., Ltd., was for 200,000 metric tons at the price of 24s. 1d. c.i.f. Alexandria.

### Imports and Dumping.

The figures issued by the Great Western Railway Company for the ports in this area under its control relating to sea-borne traffic for the four weeks ended November 22nd are very interesting, particularly on the import side. For instance, iron and steel goods, including pig iron, billets, bars, &c., imported came to 97,527 tons, which compared with 62,872 tons for the preceding four weeks and with 61,711 tons for the four weeks ended September 27th. Yet, at the same time, it should be pointed out that taking the whole of this year to November 22nd, the total imports of iron and steel came to 714,208 tons, whereas for the corresponding period of last year the quantity was 717,930 tons. One can fully appreciate the difficulty of the Government placing a duty on such imports when a deputation representing the independent tin-plate manufacturers urge the President of the Board of Trade not to adopt any such step. Imports of general merchandise also register an increase, as for the four weeks ended November 22nd the total was 60,182 tons, which ecompared with 41,729 tons for the previous month, while for the month before that the quantity was 27,525 tons. For the whole of this year to November 22nd the total general merchandise came to no less than 420,549 tons, as against 398,945 tons for the same period of last year. Exports and imports combined for this year to November 22nd amount to 24,847,560 tons, which is 6,898,138 tons less than for the same period of 1930. Exports alone declined 6,078,853 tons, and imports 819,285 tons. Coal and coke shipments are down by 5,500,831 tons at the figure of 19,403,558 tons.

### Tin-plates: Ship-repairing Items.

Three tin-plate mills at Cwmavon, Port Talbot, restarted operations on Monday after being idle for eight months. The summary on the progress of the British canning industry, circulated by the Iron and Steel Trades' Confederation, and prepared by Mr. Ivor H. Gwynne, of Swansea, is of special interest to this district, as he states that "we can look to the future with every confidence, believing that we shall have established in our borders within the next few years a market that will consume at least 50 to 60 per cent. of the possible production of Welsh tin-plates." A fairly substantial ship-repairing order has just been lost to this district, which is attributed to the onerous labour conditions prevailing in South Wales as compared with other areas. The steamer is the Norwegian vessel "Homledal," which sustained considerable damage as the result of grounding. After discharging her cargo the vessel went into dry dock at Cardiff, and when tenders were opened for the repair work it was found that local prices were higher and the time to carry out the contract longer than the conditions offered by competitors. The order was therefore placed with Cammell, Laird and Co., Ltd., of Birkenhead.

### Current Business.

The steam coal market continues to present no special feature and is very quiet all round, particularly for prompt loading. The inquiry from abroad is negligible and gives no indication of expanding. Dry coals are a very steady market, and are relatively better than other qualities, all of which are offered at the minimum prices. Some anxiety was recently caused by rumours that the Italian Government were cancelling contracts entered into for supplies for the Italian State Railways under the Hague Agreement, but it transpires that such is not the case. It is true that during certain periods of the past year they suspended taking supplies, but it is understood that these areas are to be carried forward to 1932, though nothing has so far been done in respect of contracts for next year. Coke finds a ready outlet, but patent fuel is quiet. Pitwood is not offered so freely, but at the same time the demand is very limited and, consequently, there is no improvement in prices.

## CONTRACTS.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., has received from the London and North-Eastern Railway Company an order for the supply and erection at the Down Marshalling Yard, Whitemoor, of two eddy current rail brakes, together with the necessary power plant and control equipment.

THE ATLAS DIESEL COMPANY, Ltd., has received an order for two of its two-cycle airless injection marine heavy-oil engines, type M 36 M, each developing 870 B.H.P. at 250 r.p.m., to be installed in the twin-screw yacht "Roussalka," owned by the Rt. Hon. Walter Guinness. The engines will replace existing steam turbines.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. H. S. ROWELL, M.I. Mech. E., M.I.A.E., the late director of the Research Association of British Motor Manufacturers, has been appointed chief engineer of the motor vehicle works at Basingstoke of John I. Thornycroft and Co., Ltd.

HOWDEN-LJUNGSTROM PREHEATERS (LAND), Ltd., of Caxton House, Westminster, S.W. 1, asks us to announce that, as from December 1st, 1931, its name has been changed to James Howden and Co. (Land), Ltd. The change is in name only, *personnel*, board and staff remaining unaltered.

THE STANTON IRONWORKS COMPANY, Ltd., near Nottingham, having acquired a financial interest in Wilson Brothers Pipe Fittings, Ltd., of Bridgeton Foundry, Glasgow, has entered into a working arrangement whereby the Glasgow Works will be utilised by the Stanton Company for assisting in dealing with Scottish orders and other purposes.

AN INGENIOUS TOOL.—The handy mechanic in nearly all small shops, and in some large works where the organisation restrictions are not too rigid, knows how to make good use of fragments of hacksaw blades by mounting them in handles and grinding them to shape for scrapers, or as cutting knives, or simply as small saws. Now, James Neill and Co. (Sheffield), Ltd., of Composite Steel Works, Napier-street, Sheffield, have produced *ad hoc* a most ingenious little tool of the kind. It consists of a well-made double-ended nickel-plated handle into which various blades can be instantly fitted. Mounted in one end the blades stand out at a convenient angle for certain purposes, whilst, at the other, they continue in a line with the handle. The device is known as the "Eclipse 4 S Tool," and, packed in a tin box with an equipment of blades, is retailed for a few shillings. The equipment comprises six double-edge slotting blades in three thicknesses. These blades are reversible, and for end, so that a draw stroke may be used in place of a push stroke if desirable; six No. 23 gauge tapered saw blades with toughened backs; a flat and a half-round scraper and a slitting knife, suitable for cutting belting, lead sheet, &c. The sawing blades can be replaced at a trifling expense, and the scrapers and knife only cost a few pence each. The blades are held rigidly in the handle by a very simple arrangement and a single thumb screw. The tool will appeal to the general mechanic and, in view of the season, we may add that amateurs would find it a very acceptable Christmas present.

# Current Prices for Metals and Fuels.

## IRON ORE.

| | |
|---|---|
| N.W. COAST— | |
| (1) Native | 16/- to 20/6 |
| (1) Spanish | 17/- to 19/- |
| N.E. COAST— | |
| Native | 18/- to 21/- |
| Foreign (c.i.f.) | 16/6 to 17/- |

## PIG IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| (2) SCOTLAND— | | |
| Hematite | 3 8 6 | — |
| No. 1 Foundry | 3 12 0 | — |
| No. 3 Foundry | 3 9 6 | — |
| N.E. COAST— | | |
| Hematite Mixed Nos. | 3 5 6 to 3 6 0 | |
| | 3 5 6 to 3 6 0 | |
| No. 1 | 3 6 0 to 3 6 6 | |
| | 3 6 0 to 3 6 6 | |
| Cleveland— | | |
| No. 1 | 3 1 0 | 3 1 0 |
| Siliceous Iron | 3 1 0 | 3 1 0 |
| No. 3 G.M.B. | 2 18 6 | 2 18 6 |
| No. 4 Foundry | 2 17 6 | 2 17 6 |
| No. 4 Forge | 2 17 0 | 2 17 0 |
| Mottled | 2 16 6 | 2 16 6 |
| White | 2 16 6 | 2 16 6 |
| MIDLANDS— | | |
| (a) Staffs.— | (*Delivered to Station*). | |
| All-mine (Cold Blast) | — | — |
| North Staffs. Forge | 3 1 0 | — |
| " " Foundry | 3 6 0 | — |
| (a) Northampton— | | |
| Foundry No. 3 | 3 2 6 | — |
| Forge | 2 17 6 | — |
| (a) Derbyshire— | | |
| No. 3 Foundry | 3 6 0 | — |
| Forge | 3 1 0 | — |
| (3) Lincolnshire— | | |
| No. 3 Foundry | — | — |
| No. 4 Forge | — | — |
| Basic | — | — |
| (4) N.W. COAST— | | |
| N. Lancs. and Cum.— | | |
| Hematite Mixed Nos. | 3 15 6 (a) | — |
| | 4 0 6 (b) | — |
| | 4 5 6 (c) | — |

## MANUFACTURED IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| SCOTLAND— | | |
| Crown Bars | 10 5 0 | 9 10 0 |
| Best | — | — |
| N.E. COAST— | | |
| Iron Rivets | 11 5 0 | — |
| Common Bars | 10 10 0 | — |
| Best Bars | 11 0 0 | — |
| Double Best Bars | 11 10 0 | — |
| Treble Best Bars | 12 0 0 | — |
| LANCS.— | | |
| Crown Bars | 9 15 0 | — |
| Second Quality Bars | 8 5 0 | — |
| Hoops | 12 0 0 | — |
| S. YORKS.— | | |
| Crown Bars | 9 15 0 | — |
| Best Bars | 10 15 0 | — |
| Hoops | 12 0 0 | — |
| MIDLANDS— | | |
| Crown Bars | 9 5 0 to 10 7 6 | — |
| Marked Bars (Staffs.) | 12 0 0 | — |
| Nut and Bolt Bars | 8 7 6 | — |
| Gas Tube Strip | 10 10 0 to 10 12 6 | — |

## STEEL. (*d*)

| | (6) Home. £ s. d. | (7) Export. £ s. d. |
|---|---|---|
| (5) SCOTLAND— | | |
| Boiler Plates (Marine) | 9 0 0 | 8 10 0 |
| " " (Land) | — | — |
| Ship Plates, ½in. and up | 8 15 0 | 7 15 0 |
| Sections | 8 7 6 | 7 7 6 |
| Steel Sheets, ¼in. | 7 10 0 | 7 10 0 |
| Sheets (Gal. Cor. 24 B.G.) | 10 12 6 | 9 10 0 |

## STEEL (*continued*).

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| N.E. COAST— | | |
| Ship Plates | 8 15 0 | 7 15 0 |
| Angles | 8 7 6 | 7 7 6 |
| Boiler Plates (Marine) | 10 10 0 | — |
| " " (Land) | 10 0 0 | — |
| Joists | 8 15 0 | 7 7 6 |
| Heavy Rails | 8 10 0 | — |
| Fish-plates | 12 0 0 | — |
| Channels | 10 5 0 | £9 to £9 5s. |
| Hard Billets | 8 2 6 | — |
| Soft Billets | 6 17 6 | — |
| N.W. COAST— | | |
| BARROW— | | |
| Heavy Rails | 8 5 0 | — |
| Light Rails | 8 10 0 to 8 15 0 | — |
| Billets | 6 10 0 to 9 0 0 | — |
| MANCHESTER— | | |
| Bars (Round) | 9 7 6 | — |
| " (Small Round) | 7 0 0 | — |
| Hoops (Baling) | 10 0 0 | 9 15 0 |
| " (Soft Steel) | 9 0 0 | 8 15 0 |
| Plates | 8 17 6 to 9 2 6 | — |
| " (Lancs. Boiler) | 8 17 6 to 9 0 0 | — |
| SHEFFIELD— | | |
| Siemens Acid Billets | 9 2 6 (basis) | — |
| Hard Basic | 8 2 6 and 8 12 6 | — |
| Intermediate Basic | 6 12 6 and 7 2 6 | — |
| Soft Basic | 6 0 0 | — |
| Hoops | 9 10 0 to 9 15 0 | — |
| Soft Wire Rods | 7 10 0 | — |
| MIDLANDS— | | |
| Small Rolled Bars (all British) | 7 15 0 to 8 0 0 | — |
| Small Re-rolled Bars | 6 17 6 to 7 0 0 | — |
| Billets and Sheet Bars | 5 7 6 to 5 10 0 | — |
| Galv. Sheets, f.o.b. L'pool | 9 0 0 to 9 2 6 | — |
| (2) Staffordshire Hoops | 9 10 0 | — |
| (*d*) Angles | 8 7 6 | — |
| (*d*) Joists | 8 15 0 | — |
| (*d*) Tees | 9 7 6 | — |
| (*d*) Bridge and Tank Plates | 8 17 6 | — |
| Boiler Plates | 8 12 6 | — |

## NON-FERROUS METALS.

| | |
|---|---|
| SWANSEA— | |
| Tin-plates, I.C., 20 by 14 f.o.b. | 13/9 to 14/6 |
| Block Tin (cash) | 138 5 0 |
| " (three months) | 141 2 6 |
| Copper (cash) | 38 10 0 |
| " (three months) | 39 2 6 |
| Spanish Lead (cash) | 15 10 0 |
| " " (three months) | 15 12 6 |
| Spelter (cash) | 14 10 0 |
| " (three months) | 14 18 9 |
| MANCHESTER— | |
| Copper, Best Selected Ingots | 42 0 0 |
| " Electrolytic | 47 10 0 |
| " Strong Sheets | 75 0 0 |
| " Tubes (Basis Price), lb. | 0 0 11 |
| Brass Tubes (Basis Price), lb. | 0 0 10 |
| " Condenser, lb. | 0 1 0½ |
| Lead, English | 17 0 0 |
| " Foreign | 15 10 0 |
| Spelter | 14 15 0 |
| Aluminium (per ton—raw ingot) | £85 |

## FERRO ALLOYS.

| | Per Ton. | Per Unit. |
|---|---|---|
| Tungsten Metal Powder | 2/4 per lb. | |
| Ferro Tungsten | 2/- per lb. | |
| Ferro Chrome, 4 p.c. to 6 p.c. carbon | £25 0 0 | 7/- |
| " " 6 p.c. to 8 p.c. | £24 0 0 | 7/- |
| " " 8 p.c. to 10 p.c. | £22 10 0 | 6/6 |
| " " Specially Refined | | |
| " " Max. 2 p.c. carbon | £36 0 0 | 10/- |
| " " " 1 p.c. carbon | £40 0 0 | 12/- |
| " " " 0·70 p.c. carbon | £51 0 0 | 13/- |
| " " " carbon free | 11d. per lb. | |
| Metallic Chromium | 3/1 per lb. | |
| Ferro Manganese (per ton) | £11 0 0 for home | |
| " " " | £11 10 0 for export | |
| " Silicon, 45 p.c. to 50 p.c. | £9 10 0 scale 5/- per unit | |
| " " 75 p.c. | £16 0 0 scale 7/- per unit | |
| " Vanadium | 12/9 per lb. | |
| " Molybdenum | 6/3 per lb. | |
| " Titanium (carbon free) | 9d. per lb. | |
| Nickel (per ton) | £250 to £255 | |
| Ferro Cobalt | 8/6 per lb. | |

## FUELS.

### SCOTLAND.

| | Export. |
|---|---|
| LANARKSHIRE— | |
| (f.o.b. Glasgow)—Steam | 13/9 |
| " " Ell | 14/6 |
| " " Splint | 14/3 to 15/3 |
| " " Trebles | 16/- |
| " " Doubles | 13/- to 13/6 |
| " " Singles | 10/- to 10/6 |
| AYRSHIRE— | |
| (f.o.b. Ports)—Steam | 13/6 |
| " " Jewel | 17/- |
| " " Trebles | 16/- |
| FIFESHIRE— | |
| (f.o.b. Methil or Burntisland)—Steam | 12/6 to 13/3 |
| Screened Navigation | 17/- |
| Trebles | 16/6 to 18/6 |
| Doubles | 13/6 to 14/6 |
| Singles | 10/- to 10/6 |
| LOTHIANS— | |
| (f.o.b. Leith)—Best Steam | 12/6 |
| Secondary Steam | 12/3 |
| Trebles | 16/6 |
| Doubles | 13/6 |
| Singles | 10/- to 10/6 |

### (8) N.W. COAST— ENGLAND.

| | |
|---|---|
| Steams | 22/- |
| Household | 32/6 to 51/8 |
| Coke | 20/- to 21/- |
| NORTHUMBERLAND— | |
| Best Steams | 13/6 |
| Second Steams | 12/- to 12/6 |
| Steam Smalls | 8/6 to 9/- |
| Unscreened | 12/6 to 13/- |
| Household | 27/- to 39/- |
| DURHAM— | |
| Best Gas | 14/6 |
| Second | 13/6 |
| Household | 25/- to 37/- |
| Foundry Coke | 24/- |

| SHEFFIELD— | Inland. | Export. |
|---|---|---|
| Best Hand-picked Branch | 26/- to 27/- | — |
| South Yorkshire Best | 24/- to 25/- | — |
| Derbyshire Best Bright House | 20/6 to 21/6 | — |
| Best House Coal | 22/- to 22/6 | — |
| Screened House Coal | 19/- to 20/6 | — |
| Best Screened Nuts | 17/- to 18/6 | — |
| Small Screened Nuts | 15/6 to 16/6 | — |
| Yorkshire Hards | 17/- to 18/6 | — |
| Derbyshire Hards | 17/- to 18/6 | — |
| Rough Slacks | 9/- to 10/- | — |
| Nutty Slacks | 8/- to 9/- | — |
| Smalls | 5/6 to 6/6 | — |
| Blast-furnace Coke (Inland) | 11/- to 12/- on rail at ovens | |
| Furnace and Foundry Coke (Export), f.o.b., 17/- to 18/- | | |

### CARDIFF— (9) SOUTH WALES.

| | |
|---|---|
| Steam Coals: | |
| Best Smokeless Large | 19/6 to 19/9 |
| Second Smokeless Large | 18/9 to 19/6 |
| Best Dry Large | 19/- to 19/6 |
| Ordinary Dry Large | 17/9 to 18/3 |
| Best Black Vein Large | 18/3 to 18/6 |
| Western Valley Large | 17/9 to 18/- |
| Best Eastern Valley Large | 17/7½ to 17/9 |
| Ordinary Eastern Valley Large | 17/3 to 17/6 |
| Best Steam Smalls | 13/- to 13/6 |
| Ordinary Smalls | 11/- to 13/- |
| Washed Nuts | 19/- to 30/- |
| No. 3 Rhondda Large | 19/9 to 20/- |
| " " Smalls | 15/- to 16/- |
| No. 2 " Large | 17/- to 17/3 |
| " " Through | 15/6 to 16/- |
| " " Smalls | 14/- to 14/3 |
| Foundry Coke (Export) | 22/- to 36/6 |
| Furnace Coke (Export) | 16/- to 17/6 |
| Patent Fuel | 19/- to 19/9 |
| Pitwood (ex ship) | 23/6 to 24/- |
| SWANSEA— | |
| Anthracite Coals: | |
| Best Big Vein Large | 36/- to 38/6 |
| Seconds | 27/- to 31/6 |
| Red Vein | 22/6 to 27/6 |
| Machine-made Cobbles | 41/6 to 43/6 |
| Nuts | 40/- to 43/6 |
| Beans | 28/6 to 32/6 |
| Peas | 21/- to 22/- |
| Breaker Duff | 8/6 to 9/6 |
| Rubbly Culm | 8/3 to 8/9 |
| Steam Coals: | |
| Large | 20/- to 20/6 |
| Seconds | 18/- to 20/- |
| Smalls | 11/6 to 13/- |
| Cargo Through | 16/- to 17/6 |

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. Delivered Black Country Stations.

# French Engineering Notes.

*(From our own Correspondent in Paris.)*

### Trade Balances.

CONSIDERING that for many years past the British Chamber of Commerce in Paris has vainly endeavoured to obtain facilities for British traders in France, and that the appeal of the late British Government for relief from fiscal tariffs was rejected by all the French Chambers of Commerce, it is hardly logical that the French should express such strong feeling over the policy which has been adopted in Great Britain for the salvation of home industries. In no case have the French hesitated to adopt measures, such as import licences and the super-tax on the depreciated pound, when they thought that their interests were at stake. They are now endeavouring to show that there has been a fairly equal balance of trade between the two countries, and that if Great Britain offers impediments to exchanges the British will suffer as much as the French. The figures published to support this plea are not borne out by the Customs returns, which show that during the first ten months of the present year France exported to Great Britain produce and manufactured goods to the value of 4308 million francs, while the imports from Great Britain totalled 3201 million francs. It may be observed that the imports from the United States exceeded those from Great Britain. From Germany they were no less than 5245 million francs. At the same time, the United States took from France hardly more than one-third of the value of their exports, and the French exports to Germany were much less than one-half of the imports. So far as the coal import restrictions are concerned, they have not benefited the home coalowners or the miners, who continue to swell the ranks of the unemployed, and consumers complain that they are paying too much for their coal. On the one hand, the miners have insisted upon a further restriction of coal imports, and, on the other hand, the Mayor of Rouen, accompanied by dockers' representatives, has interviewed the Prime Minister with a view to the removal of those restrictions which have thrown a large number of dockers out of work. This plea for the suppression of import licences is supported by the Commission of the Merchant Marine of the Chamber of Deputies, which protests against a measure that deprives seamen of a living. The Prime Minister has endeavoured to satisfy everyone by announcing that the foreign quotas will be reduced during December by an amount that will equal 28 per cent. of the home consumption instead of 20 per cent. The former percentage represents a limit that cannot be exceeded. At the same time, the quota will be applied to the total imports and not distributed in ratio to the imports from different countries, so that the restrictions will be greater for those coals that compete directly with French fuel, while along the seaboard, which is beyond the radius of the French supply, the restrictions will be much less and for some coals may be removed altogether. Therefore, it is probable that British coals will be treated more favourably, so that the seamen and dockers may have no reason to complain.

### Commercial Vehicles.

A feature of the Show of commercial vehicles held in Paris last week was the use of solid injection engines on nearly all the big lorries, and it is the more noteworthy because the French took little interest in this type of internal combustion engine so long as the import duties on oils eliminated any advantage the fuel could have over petrol. Since those duties were reduced builders have given more attention to the fuel injection engine, though few have been able to make a success of high-speed lorry engines of their own designs. A notable exception is the Renault firm, which has produced a reliable four-cycle mechanical fuel injection engine, and Saurer has been successful with an engine of this type, but there is hardly any French maker of big engines, except Ballot, who has manufactured smaller sizes for lorries. Now that all lorry builders want solid injection engines, they have to rely mainly upon what they can obtain abroad or what is supplied by French makers who manufacture under licence. Many of the lorries are fitted with the two-cycle Junkers engine, built by the Compagnie Lilloise des Moteurs, which is a subsidiary concern of Peugeot, the holders of the licence. Unic is building Benz engines, and other lorry manufacturers are using engines of foreign make. The vogue of the solid injection engine has created a demand which it is not easy satisfactorily to supply. That popularity is due to the necessity of getting down fuel cost to the lowest possible figure in view of the competition for road traffic, and also because petrol offers too great a risk of fiscal imposition, while the new regulations requiring a mixture of from 20 to 30 per cent. alcohol with petrol for commercial vehicle use may, it is feared, create further complications in the future. Most of the lorries are fitted with six-cylinder engines with Bosch mechanical injection. They are designed to comply with the two main requirements for economical transport—that is to say, the carrying of 2 or 3-ton loads at a speed of about 35 miles an hour, and the handling of maximum loads at fair commercial speeds. This is done with lorries on pneumatic tires, and in the case of big loads the vehicles have usually three axles with double wheels on the two back axles, so that the load is carried on ten wheels, with specially big section tires. One such lorry was shown running with a load of 36 tons. The chassis all conform to normal designs, with engine, clutch and variable speed gear constituting one unit, and on one big lorry there was an additional gear reduction on the propeller shaft.

### Public Works.

The programme of public works, involving an expenditure of 3476 million francs, has been approved by the Chamber of Deputies, so that a good deal of work for the relief of unemployment can be put in hand immediately. At the same time, the undertakings, while benefiting the building trades, are not, for the most part, of a character to do much for the manufacturing industries generally, which are in particular need of work.

# British Patent Specifications.

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

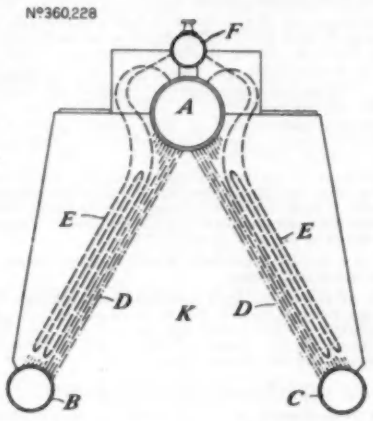
*Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.*

*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

## STEAM GENERATORS.

360,228. December 2nd, 1930.—SUPERHEATERS FOR WATER-TUBE BOILERS, H. E. Yarrow, Scotstoun, Glasgow.

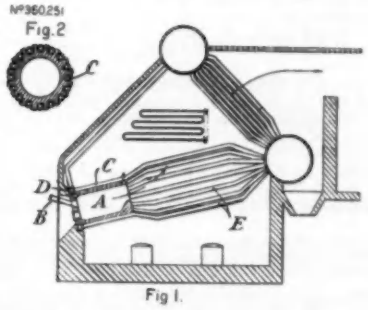
Referring to the figure, A is the saturated steam drum and B, C the water drums of an ordinary two-flow Yarrow boiler, in which the gases from the combustion space K traverse the two banks of steam generating tubes D, D connecting the water drums B, C with the saturated steam drum A and pass thence around either side of the latter drum to the uptake. A superheater is shown on each side of the boiler, each of these superheaters consisting of a plurality of multiple-bend tube




elements E, one end of each of which element is expanded into the saturated steam drum at a point near the top, or it may be expanded into a steam chamber at the top of the drum A, but separated thereform by a perforated diaphragm, so that the steam passing from the drum A to the superheater elements will be free from moisture. The other end of each superheater element E is expanded into a superheated steam drum F, from which the superheated steam passes to the point of use. The superheater drum is about one-third the length of the main drum.—*November 5th*, 1931.

360,251. December 19th, 1930.—TUBULAR FURNACES, Clarke, Chapman and Co., Ltd., Victoria Works, Gateshead-on-Tyne.

The object of this invention is to provide a furnace in which a large amount of heat may be rapidly developed without the risk of unduly rapid wear and tear of the lining of the furnace itself. The furnace is shown at A and is fed by

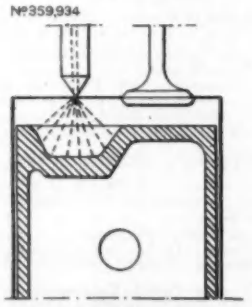



the burner B. It is lined with a thin refractory of a cross section as shown in Fig. 2. It is surrounded with water tubes C, which are spaced as closely together as is consistent with their being expanded into the header D. These tubes cool the refractory and check its deterioration. Further on they are spaced more widely apart, as shown at E, to permit the free passage of the hot gases. The tubes form part of the circulation system of a water-tube boiler.—*November 5th*, 1931.

## INTERNAL COMBUSTION ENGINES.

359,934. July 25th, 1930.—FUEL INJECTION, Motoren-Werke Mannheim A.G., vorm. Benz Abt. stationärer Motorenbau, of Carl Benzstrasse, Mannheim, Germany.

It is pointed out that in comparatively small solid injection oil engines in which the fuel jet is set excentrically in the cylinder

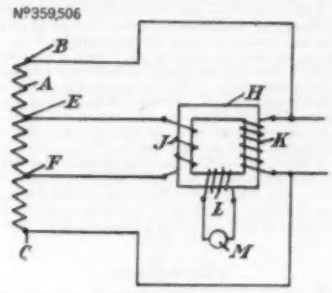



head to provide space for the inlet and exhaust valves, and a piston with a normal cavity is employed, incomplete combustion is produced by the varying lengths of the sprays of fuel before they strike the piston. The inventors, consequently, make the cavity also excentric as shown in the drawing and thereby, it is claimed, obtain a uniformity of combustion.—*October 26th*, 1931.

## DYNAMOS AND MOTORS.

359,506. April 24th, 1930.—MEANS FOR PROTECTING THE WINDINGS OF DYNAMO-ELECTRIC MACHINES, *International General Electric Company, Inc., of* 120, *Broadway, New York, U.S.A.*

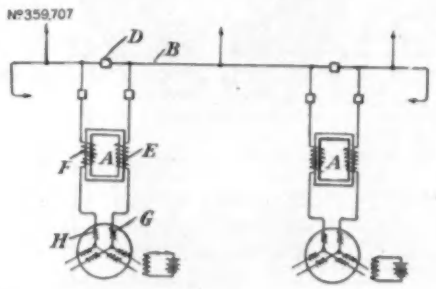
The scheme described in this specification is designed to protect A.C. generators against internal faults. A indicates one phase of the polyphase winding of an A.C. machine. The winding is tapped at the points E and F, between which a voltage exists. The two voltages are supplied to a transformer H, and the




windings J and K are so constituted with regard to the number of turns and connection that under normal conditions no resulting flux is present in the iron core. The transformer has another winding L of any desired number of turns to which an indicating or releasing relay M is connected. Under normal conditions the winding L is not energised, but if an internal fault occurs at the machine winding A, a resulting flux is set up in the transformer H which induces a voltage in the winding L and causes the relay M to respond.—*October 26th*, 1931.

359,707. October 20th, 1930.—ELECTRICAL DISTRIBUTION, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

With a view to reducing short-circuit currents, generators having more than one winding have been introduced, the windings being connected to different bus-bar sections, as shown in the diagram. In accordance with the invention, differential reactors or balancing transformers A are connected in series with the generator windings and the bus-bar sections. The coils belonging to each reactor are arranged in inductive relation with an air or iron core, and under balanced load and power factor conditions, the impedance drop of the differential reactor may be made very small. In the event of a short circuit on the

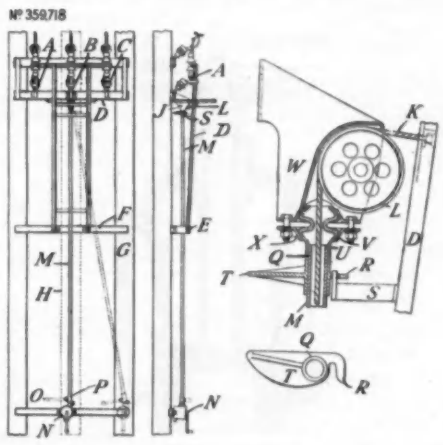



bus-bar section B, with the switch D open, the impedance of the coil E will be very great to the flow of fault current, because of the comparatively small counterbalancing magneto motive force of the coil F. Moreover, while the impedance voltage component across the coil E is opposed to the voltage generated in the winding G, there is an impedance voltage component across the coil F, which is in a direction to add to the voltage generated by the winding H. Thus if the differential reactors are properly designed, the voltage of the generator winding connected to the bus-bar section that is not directly subjected to the short circuit may be substantially the normal value. In any case of unbalance of current between the windings of the same generator the differential reactor will tend to equalise the current in the two windings.—*October 23rd*, 1931.

## SWITCHGEAR.

359,718. October 25th, 1930.—SWITCH FUSES FOR OVERHEAD TRANSMISSION LINES, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C. 2, Arthur Milnes Pooley, of Birches-lane, Kenilworth, Warwickshire, and Arthur Alexander Heath, of 54, Warwick-place, Leamington Spa, Warwickshire.

This specification describes an overhead line fuse having a




winch mounted below the switch for raising and lowering contacts and fuses. A, B, and C are fuse elements mounted on a frame D, which is pivoted to turn about a horizontal axis E, and carried on a bracket F secured to the pole G or H. A guide pulley unit is secured to the upper part of the pole. The winch cable K is attached to the hinged frame D and passes over the pulley L and through the tube M to the winch N. The tube M is carried at the bottom by a bearing mounted on or

above the winch, and at its upper end is mounted in a bearing which is preferably spherical, and may form part of the guide pulley bracket. The tube is intended to be rotated through substantially 180 deg. by an attachment to its lower end, adjacent to the winch. This attachment may be either a handle, such as O or a boss P adapted to receive the detachable winch handle. At its upper end the tube carries the locking member Q, which has a latch piece R adapted to engage and retain a hook S, projecting inwardly from the frame D, and a cam-shaped part T adapted on rotation of the tube to push the frame D outwards. The winch may be mounted vertically below the switch or in the position shown dotted. To allow of the inclination of tube due to this, as well as to compensate for errors of alignment in all directions, the top of the tube is mounted in a spherical bearing. A ball joint member U secured to the top of the tube fits in a socket formed by the surfaces V on the guide pulley bearing bracket W, and on the bearing cap X bolted to W. The inside of the ball member U is provided with an inwardly projecting circumferential ridge to guide the cable on to the pulley when the tube is not vertical. When the apparatus is in use the frame D is hoisted by the winch to place the fuse elements into engagement to close the switch. The tube M is then rotated slightly to engage the latch, and thereby relieve the winch cable of load. To open the switch, the winch is unwound to throw slack into the cable, and the tube is rotated in the other direction, whereupon the latch is first disengaged and next the cam T pushes the frame D outwards, thereby separating the switch elements with a quick break.—*October 29th*, 1931.

### FURNACES.

358,656. August 19th, 1930.—ELECTRIC FURNACES, *The British Hartford-Fairmont Syndicate, Ltd., of* 143, *Audrey House, Ely-place, London, E.C.* 1.

This specification describes a three-phase electric furnace for melting glass, waterglass, cement, or other substances, wherein large surfaces of contact between the electrodes and the material treated are required. The electrodes must not have an appreciably higher temperature than that of the molten material, otherwise the alkali will easily vaporise and a useless product will result. In order to obtain an even temperature in the molten mass, the resistance between the different phases at all points between the electrodes must be the same. By using only three electrodes, one for each phase, an even heating of the charge

No 358,656

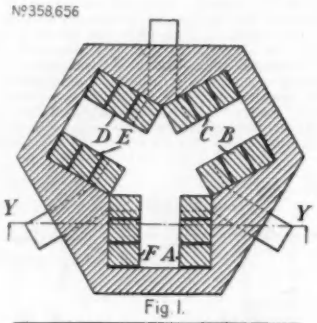



Fig. 1.

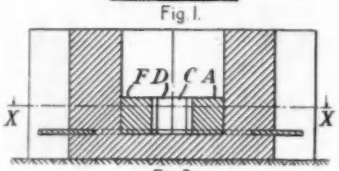



Fig. 2

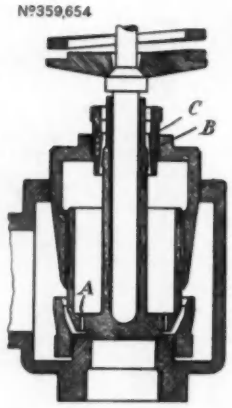
cannot be secured, as it is impracticable to arrange the electrodes in such a way that their operative surfaces will be parallel to each other so as to effect an even loading in each phase. The invention is intended to solve these difficulties in the construction of a three-phase furnace having large operative surfaces of the electrodes. The melting spaces are constituted by three recesses, preferably at an angle of 120 deg. to each other. Fig. 1 shows a furnace in horizontal section on the line X–X of Fig. 2, and Fig. 2 in cross section on the line Y–Y of Fig. 1. The electrodes A B, C D, and E F are respectively connected in pairs to the phases. Current flows between A and F, B and C, and D E. It is to be expected that when, for instance, the current passes from A to F, that a portion will be shunted from A to E, but this will only be a small proportion, owing to the greater distance and consequently the increased resistance.—*October 15th*, 1931.

### MISCELLANEOUS.

359,654. September 16th, 1930.—SAFETY VALVES, G. Ackermann, 9, Neue Bahnhofstrasse, Lichtenberg, Berlin, O. 112, Germany.

The object in the design of this safety valve has been to provide one which will open quickly and extensively to release an excessive pressure, but will not hammer on its seatings. As

No 359,654




soon as the valve lifts off its seating steam passes up through the ports A, and provides a back pressure above the valve, which is released through the annular passage between the cones B and C. This passage is gradually reduced as the valve rises, and, in consequence, the resistance to the movement of the valve is increased, and it is gradually brought to rest. The reverse action takes place when the boiler pressure drops and the valve starts to close again.—*October 29th*, 1931

## Forthcoming Engagements.

***Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.***

TO-DAY.

ALLAN GLEN'S OLD BOYS' CLUB: LONDON BRANCH.—At the Arundel Hotel, Arundel-street, Strand, W.C. 2. Annual dinner. Tickets may be obtained from Mr. J. M. Liddell, 184, Eton-road, Ilford.

ILLUMINATING ENGINEERING SOCIETY.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. The meeting called for this evening is cancelled.

INSTITUTION OF CHEMICAL ENGINEERS.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W. 1. "The Manufacture of Asphalt from Cracking Process Residues," by Mr. F. M. H. Taylor. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Victoria Embankment, W.C. 2. "Oil-filled Cables," by Mr. R. E. G. Horley. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. "The Manufacture and Use of Steel Railway Sleepers," by Mr. Raymond Carpmael. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Oxygen Machine Cutting," by Mr. C. G. Bainbridge. 7.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Queen's Hotel, Keighley. "Pumps: Ancient and Modern," by Captain E. H. Marsh. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—In the Mining Institute, Newcastle-upon-Tyne. Discussion, "Improved Marine Steam Reciprocating Engines: Does their Performance Justify their Extra Cost?" Subject to be introduced by Mr. J. N. Hendry. 6 p.m.

RAILWAY CLUB.—Manchester Hotel, Alderagate-street, E.C Twenty-fifth annual dinner.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—In the "Societies Room," No. 24, Royal Technical College, George-street, Glasgow. The Council will meet at 6.45 p.m. in Committee Room No. 26. Paper on "Notes on Plant Breakdowns and Failures," by Mr. George Ness. 7.15 p.m.

SATURDAY, DECEMBER 12TH.

HULL ASSOCIATION OF ENGINEERS.—Municipal Technical College, Park-street, Hull. "Fuel Oil and its Application to Industrial Purposes," by Mr. O. S. Sharratt. 7.15 p.m.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—In the Lecture Theatre of the Institute, Newcastle-upon-Tyne. The following paper will be open for further discussion:—"The Hydrogenation of Coal," by Dr. A. Crawford. The following papers will be read:—"A Method of Preventing Crush to Brick Stoppings and Similar Structures," by Mr. C. H. Leeds; "Stowage of the Goaf," by Professor Granville Poole and Mr. J. T. Whetton. 2.30 p.m.

MONDAY, DECEMBER 14TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "New Alloys in the Brass Foundry," by Mr. J. Arnott. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—Armstrong College, Newcastle-upon-Tyne. "The High-voltage Systems of Italy," by Mr. A. Dalla Verde. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—Storey's-gate, St. James's Park, S.W. 1. "Presses and Press Work," by Mr. W. B. Challen. 6.15 p.m.

TUESDAY, DECEMBER 15TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, S.W. 1. Discussion, "The Improvement of the Port of Valparaiso, and Extension of the Breakwater," by Mr. W. F. Stanton. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—At the North British Station Hotel, Edinburgh. "Electrical Measurement and its Service to Industry," by Mr. F. C. Knowles. 7 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C. 2. "Slipways with Side-slipping Arrangements," by Mr. A. Henderson. 7.30 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "The Past, Present, and Future of Heat-resisting Alloys," by Mr. J. Ferdinand Kayser. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. "Air Waves," by Mr. F. J. W. Whipple. 5.15 p.m.

WEDNESDAY, DECEMBER 16TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Metropole Hotel, Leeds. "Transmission," by Mr. L. H. Pomeroy. 7.15 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, S.W. 1. Students' meeting. "The Mechanical Handling of Coal at Ports," by Mr. N. G. Gedge. 6.30 p.m.

NEWCOMEN SOCIETY.—At Prince Henry's Room, 17, Fleet-street, E.C. 4. "Early Cloth Fulling and its Machinery," by Mr. E. Kilburn Scott. 5.30 p.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, S.W. 7. Meeting at 5 p.m.

ROYAL MICROSCOPICAL SOCIETY.—B.M.A. House, Tavistock-square, London, W.C. 1. Meeting at 5.30 p.m.

SOCIETY OF GLASS TECHNOLOGY.—In the Lecture Theatre of the Department of Coal Gas and Fuel Industries, The University, Leeds. General discussion, "The Inspection and Testing of Glassware, with Special Reference to Glass Containers." The discussion will be opened by Mr. J. B. Murgatroyd and continued by Mr. E. A. Coad-Pryor and others. 2 p.m.

THURSDAY, DECEMBER 17TH.

CRYSTAL PALACE SCHOOL OF PRACTICAL ENGINEERING.—In the Lecture Room. Presentation of Certificates by Mr. Norman B. Dickson. 3 p.m.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Queen's Hotel, Birmingham. Annual dinner, 7 p.m.; reception, 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—In the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. "The High-voltage Systems of Italy," to be illustrated by a cinematograph film, by Mr. A. Della Verde. 6 p.m.

INSTITUTION OF MINING AND METALLURGY.—At the Rooms of the Geological Society, Burlington House, Piccadilly, London, W. 1. "Gold and Silver as Money Metal," by Mr. T. A. Rickard. 5.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—In the Mining Institute, Newcastle-upon-Tyne. "The Super-atmospheric Oil Engine," by Mr. Harry Hunter. 6 p.m.

OLD CENTRALIANS.—Devereux Restaurant, Devereux-court, Strand, W.C. 2. Luncheon. 1 p.m.

ROYAL AERONAUTICAL SOCIETY.—In the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Control Beyond the Stall," by Dr. G. V. Lachmann. 6.30 p.m.

SCIENCE MUSEUM.—Exhibition-road, South Kensington, S.W. 7. "Stained and Painted Glass," by Mr. James Hogan. 4.45 p.m.

FRIDAY, DECEMBER 18TH.

INSTITUTE OF CHEMISTRY.—30, Russell-square, London, W.C. 1. "Third S. M. Gluckstein Memorial Lecture: The Chemist and the Community," by Sir Frank E. Smith, F.R.S. 8 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Development of the Talking Picture," by Mr. W. Harris. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "The Education of the Average Man," by Rev. C. Alington. 9 p.m.

SATURDAY, DECEMBER 19TH.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS: TEES-SIDE BRANCH, GRADUATE SECTION.—In the Cleveland Scientific and Technical Institution, Middlesbrough. Paper by Mr. H. McIvor. 7.30 p.m.

TUESDAY, DECEMBER 22ND.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Segrave Club, Queen-street, Wolverhampton. "Transmission," by Mr. L. H. Pomeroy. 7.30 p.m.

TUESDAY, DECEMBER 29TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture. The Universe of Light: Lecture I., "The Nature of Light," by Sir William Bragg, F.R.S. 3 p.m.

THURSDAY, DECEMBER 31ST.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture. The Universe of Light: Lecture II., "Light and the Eye," by Sir William Bragg, F.R.S. 3 p.m.

**1932.**

FRIDAY, JANUARY 1ST.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street S.W. 1. "Photogravure and the Intaglio Press," by Mr. B. A Gooderham. 7.30 p.m.

SATURDAY, JANUARY 2ND.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light"; Lecture III., "Light and Colour, I.," by Sir William Bragg, F.R.S. 3 p.m.

MONDAY, JANUARY 4TH.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Victoria Hotel, Wolverhampton. "The Mechanical Principles Embodied in Weighing Machines," by Mr. W. A. Benton. 7.30 p.m.

TUESDAY, JANUARY 5TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Oil Consumption in Relation to Cylinder and Piston Wear," by Mr. E. C. Ottaway. 7.45 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light, Lecture IV., Light and Colour, II.," by Sir William Bragg, F.R.S. 3 p.m.

WEDNESDAY, JANUARY 6TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "The Training of Young Automobile Engineers," by Mr. B. G. Robbins. 7.30 p.m.

THURSDAY, JANUARY 7TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—In the Chamber of Commerce, Birmingham. "The Underpinning of a Heavy River Wall," by Mr. Wm. Muirhead. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light, Lecture V., Light from the Sky," by Sir William Bragg, F.R.S. 3 p.m.

FRIDAY, JANUARY 8TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, St. James's Park, London, S.W. 1. Thomas Lowe Gray Lecture, "Modern Types of Propelling Machinery for Mercantile Marine Use," by Mr. Sterry B. Freeman. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Refrigeration: Modern Practice and Practical Calculations," by Mr. B. C. Oldham. 7.30 p.m.

SATURDAY, JANUARY 9TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Christmas Lecture, "The Universe of Light, Lecture VI., Light from the Sun and the Stars," by Sir William Bragg, F.R.S. 3 p.m.

TUESDAY, JANUARY 12TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Graduates' Meeting, Watergate House, Adelphi, W.C. 2. "Carburisation," by Mr. E. W. Knott. 7.25 p.m.

THURSDAY, JANUARY 14TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—In the Chamber of Commerce, Birmingham. Vernon Harcourt Lecture, "The Mechanical Handling of Coal at Ports," by Mr. N. G. Gedye, 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH. Hotel Metropole, Leeds. Annual General Meeting. "Recent Developments in the Treatment of Boiler Water," by Dr. A. W. Chapman. 7.30 p.m.

FRIDAY, JANUARY 15TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, St. James's Park, S.W. 1. Informal Meeting. Discussion on "Industrial Conditions in Russia," introduced by Mr. J. Fearn. 7 p.m.

WEDNESDAY, JANUARY 27TH.

BRITISH WOOD PRESERVING ASSOCIATION.—In the Lecture Hall, Auctioneers' and Estate Agents' Institute, 29, Lincoln's Inn-fields, London, W.C. 2. "Diseases of Timber," by Mr. K. St. G. Cartwright. 6 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineers' Club, Manchester. "Transmission," by Mr. L. H. Pomeroy. 7 p.m.